ADULT CHINOOK ESCAPEMENT ASSESSMENT CONDUCTED ON THE COWICHAN RIVER DURING 2004

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ABSTRACT

Nagtegaal, D.A., Carter, E.W., and Hop Wo, N.K. 2006. Adult chinook escapement assessment conducted on the Cowichan River during 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2765: 53 p.

In 2004, the Biological Sciences Branch, Pacific Biological Station, continued a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Cowichan River. This in-depth escapement assessment project has been in place since 1988. Major components of this study included: i) enumerating spawners and total return, ii) estimating First Nations food fish catch, iii) recording hatchery broodstock removals, and iv) collecting biological, environmental and coded-wire tag data. Population estimates for adult and jack chinook were determined based on the fence count since this was considered to be the most accurate enumeration method. A carcass mark-recapture study was conducted on the spawning grounds to augment the collection of biological data and to supplement the fence count population estimate. The total return of adult chinook to the Cowichan River was estimated to be 3,341 fish of which 2,146 spawned naturally in the river. A total of 575 adult chinook were collected for hatchery broodstock, 320 adults were estimated as captured in the First Nations food fishery, and approximately 300 adults were lost to seal predation.

RÉSUMÉ

Nagtegaal, D.A., Carter, E.W., and Hop Wo,N.K. 2006. Adult chinook escapement assessment conducted on the Cowichan River during 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2765: 53 p.

En 2004, la Direction des sciences biologiques de la Station biologique du Pacifique a poursuivi dans la rivière Cowichan l'étude sur la productivité du saumon quinnat (Oncorhynchus tshawytscha), un projet d'évaluation approfondie de l'échappée, lancée en 1988. Cette étude comporte les principaux éléments suivants : i) dénombrement des géniteurs et de la remonte totale, ii) estimation du volume des prises autochtones à des fins alimentaires; iii) consignation des prélèvements de géniteurs d'élevage et iv) collecte de données biologiques et environnementales et de données de micromarques magnétisées codées. Les effectifs de quinnats adultes et unibermarins sont estimés à partir des données de barrière de dénombrement étant donné que cette méthode de dénombrement est considérée comme étant la plus précise. Des carcasses de saumons étiquetés sont récupérés dans les frayères de sorte à enrichir les données biologiques et améliorer l'estimation des effectifs fondée sur les données de barrière de dénombrement. La remonte totale de quinnats adultes dans la Cowichan en 2004 a été estimée comme se chiffrant à 3 341 poissons, dont 2 146 ont frayé naturellement dans la rivière. Un total de 575 géniteurs ont été prélevés aux fins d'élevage et, d'après les estimations, 320 adultes ont été capturés dans le cadre de la pêche autochtone à des fins alimentaires et 300 autres ont été la proie des phoques.

INTRODUCTION

Chinook stocks are invaluable to both commercial and recreational fisheries of the Pacific Northwest (Collicut and Shardlow 1995). In spite of protective measures, chinook salmon abundance has continued to decline. This trend has resulted in the recent addition of chinook to the list of threatened and endangered species in the United States (Waples 1991). The problem of declining stocks is similarly serious on the West Coast of Canada, and has potential ramifications regarding the sustainability of British Columbia's fishing industry (Argue et al. 1983). Over the past several years, considerable interest has been focused on the chinook stocks of the southern portion of the Strait of Georgia due to the decline in these stocks and their importance to local fisheries (Hardie et al. 2003; Tompkins et al. 2005). The Stock Assessment Division, Pacific Biological Station, initiated a study of chinook productivity to assess rebuilding strategies and to evaluate the effects of harvest management policies for these stocks. In the fall of 1988, a study was implemented on Cowichan River chinook with additional information collected from the Squamish and Nanaimo River stocks. These three stocks within the framework of the Pacific Salmon Treaty between Canada and the United States were identified as exploitation and escapement indicators and deemed to represent the status of all lower Georgia Strait chinook stocks (PSC 1990). Since then, due to logistical reasons the Squamish River system was dropped as an indicator and in 2002 the Nanaimo River system was dropped as well.

Major hatchery production of chinook on the Cowichan River began in 1980 (Cross et al. 1991). Chinook fry releases have increased from 64,681 in 1980 to 1.64 million in 2004. Coded-wire tag (CWT) releases also began in 1980 and by 2004 approximately 13.7% of the chinook released carried coded-wire tags.

This report presents the results of the study completed during 2004. The objectives included:

1. enumerating chinook, coho and chum salmon migrating past the counting fence,
2. estimating First Nations food fishery catch,
3. recording hatchery broodstock removals,
4. collecting biological data and sampling coded-wire tag recoveries,
5. implementing a carcass mark-recapture study for both adult and jack chinook, and
6. monitoring results of the Cowichan River Water Management Plan.

METHODOLOGY

A detailed description of the methodology is presented in Nagtegaal et al. (1994b). A summary of the methods is presented below along with any changes that were incorporated during the 2004 study.

STUDY AREA

The Cowichan River watershed is located on the Southeast coast of Vancouver Island and drains an area totalling 826 km^2. The Cowichan River system includes Cowichan, Bear, Mesachie, Somenos, and Quamichan lakes. Cowichan Lake (62 km^2), the largest of the five lakes, is situated approximately 50 km west of the Cowichan Bay estuary. Discharge from a flow control dam situated at the outlet of Cowichan Lake ranges from 7 to 326 m^3/s, and averages 44.9 m^3/s (Fielden and Holtby 1987). A total of 26 tributaries drain into the Cowichan River. The largest of these is the Koksilah River, which intersects the mainstem of the Cowichan River approximately 2.5 km upstream of the estuary. The Cowichan River watershed system is a typical Vancouver Island and coastal British Columbia stream in which maximum flows occur during winter months due to heavy rainfall (McDougall 1985).

The Cowichan River supports many salmonid species including chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), chum (*Oncorhynchus keta*), sockeye (*Oncorhynchus nerka*), and pink (*Oncorhynchus gorbuscha*) salmon; as well as cutthroat trout (*Oncorhynchus clarki*), steelhead trout (*Oncorhynchus mykiss*), kokanee salmon (*Oncorhynchus nerka*), and dolly varden char (*Salvelinus malma*). Attempts have been made to introduce several other species including: atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*) (Perrin et al. 1988). The salmonids of the Cowichan River support several vital fisheries, which include a First Nations food fishery, tidal sport fishery, and a commercial ocean fishery.

ENUMERATION FENCE

The counting fence was placed upstream of the city of Duncan, in the same location as in previous years (Figure 1). The design incorporated a resistance board weir with a counting raceway (adjustable flashboard) and trap box adjacent to a counting tower equipped with floodlights. Counts were continuously recorded by 15-minute interval for adult and jack chinook, adult and jack coho, and chum salmon. If identification was in doubt, fish were recorded as unknown. Water depth, temperature, water clarity, and weather condition were recorded three times per day. The fence was checked regularly for any breaches and cleaned of leaves and other debris. Any removal of broodstock at the fence site by hatchery staff was recorded.

In 2004, the fence was installed with updated panels. All cross-members joining the PVC pipes along with the resistance boards were made entirely of aluminium, therefore negating the need for gear clamps to secure the pipes. The new panel design successfully reduced the areas where leaves could become entangled in the fence.

Fence Enumeration Video

An underwater video camera was installed at the fence site in order obtain an independent estimate of chinook mark rate. The camera was positioned in the trap box providing a ¾ view of fish swimming upstream. The video was recorded by a VCR located in the counting tower and

tapes were reviewed at a later date. Video data were recorded by species with chinook being differentiated as being either adult or jack. Adipose fin clip status was either recorded as present, absent, or unknown.

SWIM SURVEYS

In an effort to maintain consistency with historical data sets, swim surveys were conducted, in conjunction with Cowichan Tribes Aboriginal Fisheries Management (CTAF), to estimate the spawning population of chinook. Swims were made in the upper section of the river only (Figure 1) with counts extrapolated to the total system. Each survey was conducted by three experienced swimmers while one person in a canoe recorded the data. Each swimmer (one in the middle and one on each side of the river) counted the fish seen within their range of visibility. The three swimmers attempted to keep abreast as they approached each pool while the person in the canoe lagged behind within hailing distance. Counts were recorded by pool/riffle and then compiled by river section. To maintain consistency in counting procedures the same swim team was used for each survey whenever possible. Based on the historical distribution of spawners, swim counts were expanded by a factor of 3.4 to derive an estimate of total escapement (Nagtegaal et al. 1994a). This expansion factor was consistently applied to swim counts with no adjustments made for run timing or changes to spawner distribution. A final escapement estimate was then determined based on consultation with Fishery Officers using the swim counts in conjunction with other anecdotal information.

It was intended that the swim survey estimates remain independent of the fence count. However, even though fence counts were not passed on to the swim teams during the season, general trends in escapement numbers were known.

FIRST NATIONS FOOD FISHERY

In 1990, a systematic approach was developed by the Cowichan Tribes Aboriginal Fisheries Management program to monitor the fishery more closely and to better estimate the First Nations food fish catch (Paige 1992, 1997). This approach involved recording catch and effort by management zone within the First Nations fishing boundaries (Figure 2). A crew of four observers patrolled the fishery on a daily basis and interviewed fishermen for numbers caught by area and total time spent fishing. In this way, weekly estimates of catch per unit effort (CPUE) were obtained. CPUE was adjusted for daily changes in fishing effort and differences in effort among fishing zones. These data were then extrapolated over time and area to estimate total catch by week and summed over all weeks to estimate the total catch for 2004.

$$CATCH \equiv \sum_{n}^{w=1} CPUE_{w} \times EFFORT_{d}$$

where w refers to the time interval for catch (week), and d refers to the time interval for effort (day). No confidence limits were calculated (Paige 1997).

For some years since 1988, an observer was employed to independently collect catch and biological data from the in-river First Nations fishery. In 2004 DFO hired an observer to conduct

this work which would allow the CTAF estimate to be independently verified. The intent in 2004 was to cooperatively work with CTAF and generate a common resolved catch estimate. Unfortunately, the CTAF were unable to regularly monitor the fishery and as a result did not have the data to determine a final catch estimate. In 2004, the resolved catch estimate was determined using the data collected by the independent DFO observer and applying it to the methodology developed by the CTAF.

BIOLOGICAL DATA

Biological data for chinook were collected from hatchery broodstock samples and from carcasses recovered on the spawning grounds. Data collected included sex, post orbital-hypural (POH) length, adipose fin status (present/absent), as well as scales obtained for age analysis. All chinook sampled from either the spawning grounds or hatchery broodstock were examined for the presence of a CWT using either a Northwest Marine Technology[1] Handheld Wand Detector or a Northwest Marine Technology[1] R9500 Tunnel Detector. All adipose fin clipped chinook and fish suspected of having a CWT had heads removed for decoding of coded-wire tags as well as scales obtained for age analysis. All chinook recovered on the spawning grounds were sampled and spawning condition was noted.

Hatchery staff randomly collected biological data from approximately 25% of the chinook broodstock and from all additional chinook suspected of carrying a CWT.

MARK-RECAPTURE

A mark-recapture program involving the tagging and subsequent recovery of chinook jack and adult carcasses was conducted on the spawning grounds. Crews consisting of two or three individuals surveyed the upper section of the river each day using an inflatable boat (Figure 1). All chinook carcasses encountered were individually tagged with a Ketchum[2] aluminum sheep ear tag on the left operculum and immediately released in the same area as captured. Location of capture and release, tag number, spawning condition, POH length, sex, and adipose fin status (present or absent) were recorded for each carcass. Tag number and recovery location were recorded for all previously marked carcasses, which were then removed from the system.

The section of the river selected for the mark-recapture study is located above Skutz Falls and represents the area where the majority of chinook spawning has typically occurred. A 4.2 m pole with a gaff hook attached to the end was used to recover carcasses. Carcasses that ended up in deep pools were occasionally unable to be retrieved.

Mark-recapture estimates were generated using the Petersen model (Chapman modification) stratified by sex (Ricker 1975). Data were stratified to minimize the effects of differential tagging and tag recovery between sexes. This study follows the estimation procedure as outlined in previous reports (Nagtegaal et al. 1994a, 1994b, 1994c).

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[1] Northwest Marine Technology Inc., Shaw Island, Washington, U.S.A.
[2] Ketchum Manufacturing Ltd., Ottawa, Canada.

To determine the validity of the mark-recapture estimate, potential biases were assessed to test for violations of the assumptions inherent in the Petersen mark-recapture method (Ricker 1975; Seber 1982; Krebs 1989). Sex related bias in the application sample was examined by comparing the sex ratio of the marked versus the unmarked recoveries. Sex related bias in the recovery sample was assessed by comparing the sex ratio of recovered samples with unrecovered samples. Size bias in the application sample was examined by comparing lengths of marked versus unmarked recoveries. Size bias in the recovery sample was examined by comparing lengths of recovered and unrecovered tag samples. Statistical comparisons of length data were carried out using pooled variance Student's t-tests. Temporal bias in application samples was assessed by stratifying sampling dates into approximately equal periods and comparing mark incidence among strata. Similarly, temporal bias in recovery samples was stratified by dates and the ratio of tagged recoveries to tags applied was compared. Statistical assessments of sex and period biases were carried out using Chi-square tests.

WATER MANAGEMENT PLAN

Low flow and low water levels likely result in delayed fish movement and higher water temperatures potentially increasing levels of diseases and parasites. During particularly low water levels the river flow can be increased with a controlled water release from the Lake Cowichan Weir. Discussions between NorskeCanada, Fisheries and Oceans Canada, Land and Water British Columbia, Cowichan River Hatchery, Cowichan Tribes and other user groups lead to a water management plan for the Cowichan River. This plan was committed to maintaining Cowichan River water levels for fish, First Nations and recreational users.

POPULATION ESTIMATE

Chinook population estimates are based on fence data when enumeration conditions are good and when counts are deemed reliable. Before a final estimate is reached the fence count will be assessed to see if it is representative of a complete chinook run. If necessary, adjustments to account for chinook arriving prior to installation and after fence removal will be made. Data are then adjusted by jack/adult ratios observed from spawning ground chinook recoveries. Total run size is calculated by using adjusted fence count data, First Nations food fishery removals, hatchery broodstock removals and seal predation estimates. The mark-recapture estimate is used in years when fence count data are unreliable.

RESULTS

ENUMERATION FENCE

The enumeration fence was installed upstream from the City of Duncan at the traditional site (Figure 1) and was operational from 10 September to 27 October. Water visibility was relatively good throughout the study with 15 days recorded as moderately cloudy and two days noted as cloudy (Table 1). As a result, conditions were favourable for viewing fish migration

past the counting tower and all counts are deemed to be reliable. A total of 2,002 chinook adults, 1,003 chinook jacks, 6,238 coho adults and 824 coho jacks were counted migrating past the enumeration fence. In addition, 6,875 chums, three pinks and 21 unidentified fish were enumerated at the fence site (Table 1). Since there were no breaches of the fence during the project it was assumed that all fish migrating past the fence during the study period were enumerated.

In past years, chinook jacks have been prominent during the early segment of the return migration often matching adult chinook counts. In 2004, the proportion of jack chinook mirrored the overall temporal pattern of adult chinook migration past the fence (Table 1, Figures 3a, 3b).

The pattern of daily migration past the fence was examined by summarizing hourly counts throughout the program (Table 2). A major peak in migration for both adult and jack chinook occurred between 0700 and 1000 hrs. During this period, 41.0% of adult chinook and 37.1% of jack chinook moved past the fence site.

In past years, tower counts and species identification were verified on several occasions throughout the run by capturing all fish migrating past the fence during one counting segment in the upstream trap box. With the addition of video monitoring, this practise was not carried out in 2004.

Video Enumeration Data

During 2004, three videos were chosen to be analysed for chinook mark rates. These videos were primarily chosen because of the volume of fish expected to be captured on tape. The tapes were recorded on 06, 08, and 18 October. Of the 202 fish identified as chinook, six adults (5.04%) and five jacks (10.64%) were recorded as being marked while 113 adults and 42 jacks were recorded as unmarked. Ten adult and 26 jack chinook were recorded as having an unknown adipose status (Table 3).

SWIM SURVEYS

Swim information for one survey was available in 2004. The swim survey was conducted on 07 October where 58 adult chinook, 25 jack chinook, and one adult coho were enumerated between Bird House Pool and Three Firs Pool (Table 4, Figure 1). A summary of all visual surveys conducted by DFO Fishery Officers and by the Cowichan Tribes Aboriginal Fisheries Management group from 1981 to 2004 is presented in Table 4.

FIRST NATIONS FOOD FISHERY

Historical estimates of the number of chinook captured in the in-river First Nations food fishery are presented in Table 5 and Figure 4. In 2004, there was no official Cowichan Tribes food fishery estimate based on CTAF methodology. Instead only an independent DFO fisheries observer collected data and estimated First Nations food fishery catches at 320 adult chinook,

four jack chinook, and 244 adult coho. These catch estimates were agreed on by both CTAF and DFO staff. In addition, if non-catch mortalities (fish that escaped capture but died before spawning due to fishery induced injuries) were included, the impact of the fishery would likely be more significant.

HATCHERY COMPONENT

Between 27 September and 10 November, Cowichan River Hatchery staff collected 277 male, 298 female, and 20 jack chinook from above and below the fence site (Table 6). The total number of chinook removed from the river for hatchery broodstock was within the range required for hatchery production (Table 7). Age analysis of scale samples revealed the majority of chinook used in hatchery broodstock were three or four year olds, 53.9% and 30.4%, respectively (Table 8).

BIOLOGICAL DATA

A total of 195 male, 232 female and 132 jack chinook carcasses were recovered on the spawning grounds and measured for post orbital-hypural length (Table 9). The length of adult male chinook carcasses ranged from 35.9 cm to 79.3 cm and averaged 60.6 cm while female carcasses ranged from 31.0 to 84.0 cm and averaged 65.0 cm. Jack chinook carcasses ranged in length from 22.7 to 57.7 cm and averaged 39.9 cm. A total of three male, eight female and five jack chinook (representing 1.5%, 3.4% and 3.8%, respectively) recovered from the spawning grounds had clipped adipose fins (Table 9). The majority of adult chinook were three or four years old (47.1% and 43.2%, respectively) while most fish identified as jack chinook (92.2 %) were two years old (Table 10).

A total of 34 male, 73 female and eight jack chinook were randomly collected from broodstock sampling (Table 11). Post orbital-hypural length measurements of male chinook ranged from 43.0 to 86.2 cm and averaged 57.7 cm while female chinook ranged from 41.5 to 78.5 cm and averaged 65.3 cm. Jack chinook ranged in size from 35.0 cm to 51.0 cm and averaged 43.3 cm. A total of four male, nine female and three jack chinook were missing adipose fins (11.8%, 12.3% and 37.5%, respectively) (Table 11).

There was a statistically significant difference present when the lengths of male and jack chinook carcasses recovered on the spawning grounds were compared to those samples obtained from hatchery broodstock (Student's t-test: $t = 2.162$; $p<0.05$ and $t=1.964$; $p<0.05$ for males and jacks, respectively). There was no statistically significant difference when mean lengths of female chinook recovered from the spawning grounds or obtained from hatchery broodstock (Student's t-test: $t = 0.329$; $p<0.05$).

Analysis reveals statistically significant differences in the adipose fin clip rates between male and female chinook carcasses recovered on the spawning grounds and those recovered from hatchery broodstock (Chi-square = 10.212; $p<0.01$ and Chi-square = 8.320; $p<0.01$for males and females, respectively). A comparison between adipose fin clip rates obtained from fence video data, carcass mark-recapture, and hatchery broodstock was also calculated. However, due to the

inability to accurately differentiate sex on video, males and females are combined for the analysis. This also yielded statistical differences (Chi-square = 17.957; $p<0.01$ and Chi-square = 14.571; $p<0.01$, for adults and jacks, respectively). When video data are compared with only deadpitch data, no statistical difference is apparent (Chi-square = 3.258; $p<0.01$ and Chi-square = 3.084; $p<0.01$ for adults and jacks, respectively). Alternatively, when video data are compared with only broodstock data, no statistical difference is apparent (Chi-square = 3.696; $p<0.01$ and Chi-square = 3.969; $p<0.01$ for adults and jacks, respectively).

Sixteen chinook heads were missing an adipose fin and subsequently collected from the spawning grounds for CWT analysis. Thirteen of the heads yielded CWT information, while two contained no pins and the information for one head was lost. Most chinook (92.3%) identified as having a CWT were released by the Cowichan River Hatchery with a majority (58.3%) of fish released during the 2001 brood year (Table 12). One chinook is found to have been released from the Samish Hatchery as part of the 2000 brood year strategy. This chinook was released into Friday Creek, a tributary of Samish River, located South of Bellingham in Washington State. A summary of all chinook releases from the Cowichan River Hatchery since 1979 is presented in Table 13.

ENVIRONMENTAL INFORMATION

Environmental data collected at the fence site included water temperature, visibility and water depth (Table 1). Water temperature was relatively stable throughout the duration of the study with the daily average between 12°C and 17°C (Figure 3a). Water depth at the fence site continually increased as part of the water release strategy (Figure 3b).

River discharge was recorded at the Water Survey Canada station below the Island Highway Bridge in the City of Duncan (Figure 1). During 2004, mean monthly discharge was below the period average between February to August. It is worth noting that the first two weeks of September also had lower than average flows, with a mean discharge rate of 3.81 m^3/s. The monthly discharge rates were similar to the period mean for the remaining months throughout the year (Figure 5). High river discharge levels eventually ended the fence study on 27 October (Table 14).

CARCASS MARK-RECAPTURE

Between 02 November and 09 December a total of 195 male, 233 female and 132 jack chinook carcasses were tagged and released in the upper Cowichan River (Table 15, 16). Of the 142 carcasses recovered with tags, 46 (32.4%) were male, 78 (54.9%) were female, 13 (9.2%) were jack chinook and five (3.5%) were unknown chinook. Using the Petersen estimator, the adult chinook spawning ground population size was determined to be 1,898 fish (95% CI: 1,606 to 2,190), while the jack chinook population was estimated to be 1,387 fish (95% CI: 719 to 2,055) (Table 17).

Potential Biases

The assessment of sampling selectivity had several potential biases in the carcass mark-recapture study.

1. Temporal bias: Temporal bias in the tagging sample was examined by stratifying the mark incidence rate into six recovery periods (Table 18). There was no significant temporal bias in the application sample for male or female adult chinook (Chi-Square = 3.94; $p<0.01$, Chi-Square = 4.19; $p<0.01$).

Temporal bias in the recovery sample was analysed by stratifying the recovery rates into six application periods (Table 19). No statistical difference was detectable in the recovery sample for both male and female adult chinook (Chi-square = 5.69; $p<0.01$ and Chi-square =7.82; $p<0.01$, males and females, respectively).

2. Fish Sex: Sex related bias was examined by comparing the sex ratio of the marked and unmarked spawning ground recoveries by application sample and by recovery sample. No sex related bias was evident when comparing male and female chinook populations (Chi-square =5.04; $p<0.01$ and Chi-square = 2.80; $p<0.01$, application sample and recovery sample, respectively) (Table 20). When jack chinook were included in the application and recovery samples significant bias was apparent in both the application and the recovery samples (Chi-square = 25.58; $p<0.01$, and Chi-square =16.34; $p<0.01$, application sample and recovery sample, respectively) (Table 21).

3. Size bias: Size related bias was examined by comparing the POH mean lengths of unrecovered marked chinook and recaptured chinook by sex. No size bias was evident in the recovery sample for adult male, adult female and jack chinook (Student's t-test: $t=1.451$; $p<0.01$, $t=0.110$; $p<0.01$, and $t=1.174$; $p<0.01$, for males, females and jacks respectively).

4. Location bias: Spatial bias was not examined due to insufficient sample size in the middle section of the river.

WATER MANAGEMENT PLAN

In 2004, due to water availability, a new water release strategy was employed. This new release approach allowed for a longer sustained water release with planned increases to test two main interests. The first was to determine how much water discharge the new fence design could sustain without the risk of damage. It was determined that the maximum discharge the fence can incur while still being safely operated is 800 ft^3/s or 22.65 m^3/s. However, this is very dependant on the amount and type of debris within the river. The second was to determine if steady water flows would encourage fish movement past the fence site as opposed to the traditional pulse releases of drier years.

The release strategy commenced on 16 September where water output at the weir increased from 4.25 m^3/s (150 ft^3/s) to 7.08 m^3/s (250 ft^3/s). The next increase occurred on 24 September where river discharge was doubled to 14.16 m^3/s (500 ft^3/s). Smaller alterations in weir outflow

took place on 29 September where flow increased to 15.57 m^3/s (550 ft^3/s) and 02 October to 16.99 m^3/s (600 ft^3/s). On 08 October, the outflow reached the season peak at 22.65 m^3/s (800 ft^3/s), but was reduced the following day to 19.82 m^3/s (700 ft^3/s), and on 10 October it was further reduced to 16.99 m^3/s (600 ft^3/s). The final alteration in weir discharge occurred on 14 October when flow was increased to 22.65 m^3/s (800 ft^3/s).

Peak chinook movement occurred on 25 September where 405 adult chinook and 239 jack chinook migrated past the fence site (20.23% and 23.83% of fence enumeration, respectively). Two smaller chinook migration peaks occurred on days corresponding to increased output from the weir at Cowichan Lake. The first occurred on 17 and 18 September where 283 adult and 110 jack chinook migrated past the fence (14.14% and 10.97% of fence enumeration, respectively). The second occurred on 09 October where 131 adult and 49 jack chinook swam upstream (6.54% and 4.89% of fence enumeration, respectively) (Table 1).

POPULATION ESTIMATE

Escapement and total return estimates for 2004 were determined using fence count data since these are considered to be the most accurate enumeration method. Although the fence project continued until nearly the end of October, we know that some component of the run passed by after removal. The 2004 fence enumeration was therefore extrapolated using the combined fence results obtained from 1991 (19 August to 11 November), 1993 (23 August to 22 November), 1994 (15 August to 13 November), 1998 (05 September to 08 November), and 2002 (03 September to 13 November) (Nagtegaal et al. 1994b, Nagtegaal et al. 1995a, Nagtegaal et al. 1995b, Nagtegaal and Carter 1998, Nagtegaal et al. 2004). The 2004 adult chinook fence enumeration of 2,002 was extrapolated to 2,226 fish while the jack chinook estimate was increased from 1,003 to 1,503 fish.

After reviewing both spawning ground carcass recovery and hatchery broodstock collection data, it became evident that the chinook fence count did not accurately reflect the true jack to adult ratio. Analysing the lengths of jack and adult chinook with the traditionally accepted jack designated length of 450 mm revealed an overlapping of age groups (Figure 6). As a result, the spawning ground carcass recovery data were utilized to apportion the adjusted chinook fence count with a more reflective ratio of jack and adult chinook within the population. This was accomplished by comparing age data with length data to calculate the proportion of two year old jack chinook with lengths greater then 450 mm (14.3%) and the proportion of three year old or greater adult chinook with lengths of 450 mm or less (0.8%). The extrapolated fence count data were then adjusted by these proportions yielding total chinook fence counts of 2,226 adults and 1,503 jacks.

The number of naturally spawning adult chinook in the Cowichan River during 2004 was determined to be the fence count minus any broodstock removals or First Nations fishery catch from areas above the fence. Following this methodology, the total number of chinook spawning in the Cowichan River was estimated to be 2,146 adults and 1,503 jacks. The total return of adult chinook to the Cowichan River was determined to be the sum of the adjusted fence count with the addition of broodstock removals and the First Nations fishery catch. A further 300 fish

were added to this total to account for chinook lost to seal predation in the Cowichan estuary (see discussion for details). Following this methodology, the total return of chinook to the Cowichan River was estimated to be 3,341 adults and 1,527 jacks. Annual summaries of total returns, natural spawners, broodstock removals, and Native catches for adult and jack chinook in the Cowichan River are presented in Table 22 and Table 23, respectively.

DISCUSSION

ENUMERATION FENCE

The floating fence design functioned well in the flow conditions that existed in the lower Cowichan River during the fall of 2004. While the fence was intended to be self-cleaning, field staff were required to regularly remove leafy debris from the fence panels during periods of heavy rain and related high flows. During such periods, fence panels became over burdened and could not remain afloat without the removal of debris. While this difficulty has been observed in other fence studies (Cousens et al. 1982, Johnston et al. 1986) it is likely that the extent of the problem varies by year and location.

During many of the past monitoring studies, high flows have caused fence damage or forced early removal resulting in incomplete fence counts. During the current study, high flows resulted in the project being discontinued on 27 October. Past studies have indicated that between 15% to 24% of the chinook run arrives after October 30 (Nagtegaal and Carter 1998, Nagtegaal et al. 2004) and this proportion is usually incorporated into the final estimate of chinook migration past the fence. In the current study, the adult chinook count was increased by 29.2% to adjust for an incomplete run enumeration.

Several of the past fence enumeration studies conducted on the Cowichan River have noted the mis-identification of jack versus adult chinook by observers monitoring the migration of chinook past the fence (Nagtegaal and Carter 1998, 2000). While trap box verifications of observer counts were not carried out in 2004, it became clear from both spawning ground and hatchery broodstock data that the adult to jack ratio recorded at the fence was not reflective of the true population parameters. Since there were a number of jack chinook at the upper end of the size distribution, it appears as if some of these fish were counted as adults. This seems likely as it would be very difficult to determine the size of a moving fish to within a few centimetres when viewing them from a counting tower well above the river. As a result, the total chinook fence count was adjusted by the ratio of adult and jack chinook sampled during the spawning ground carcass recovery.

Video Enumeration Data

Video enumeration data provided another means of obtaining chinook mark rates. In past years, mark rates obtained from carcass mark-recapture and broodstock collection were significantly different. An example being 2000, when the mark rates of female chinook obtained from carcass mark-recapture and broodstock collection were found to be statistically different (Chi-Square = 11.963; $p<0.01$) (Diewert et al. 2003). Another example was in 2001, when the

mark rates of male chinook obtained from carcass mark-recapture and broodstock collection were found to be statistically different (Chi-Square = 8.788; $p<0.01$) (Hop Wo et al. 2003). As in previous years, the mark rates obtained from carcass mark-recapture and hatchery broodstock are statistically different. When comparing the mark rates obtained from video data with either carcass mark-recapture data or hatchery broodstock data, video data does not support one method of collection over the other.

SWIM SURVEYS

The biases typically associated with swim surveys and the extrapolation of actual swim counts to historical estimates warrant some considerations (Burns unpubl.). Assumptions concerning the distribution of chinook in the river at the time of the survey are the basis for expanding these counts to estimate total escapement (T. Fields, 230 Underwood St., Duncan, B.C. V9L-3X3; pers. comm.). In 1991, it became apparent that during high water flow conditions in early fall, expansions based on the swim survey results overestimated total escapement (Nagtegaal et al. 1994b). The results of the 1992 swim surveys support the hypothesis that during low water flow conditions in late fall, expansions based on swim survey results underestimate the number of spawners (Nagtegaal et al. 1994c). Low flow conditions lead to underestimation of spawners because the distribution of fish in the river is affected by flow. Generally, in low water years, not as many fish make it to the traditional spawning areas above Skutz Falls. The expansion of swim surveys conducted in the upper area alone tends to underestimate the number of fish. Conversely, during high water years most of the fish make it above Skutz Falls so the expansion factor tends to overestimate the number of fish.

Only one swim survey was conducted on the Cowichan River during 2004. This survey is useful in estimating chinook distribution within the river on 07 October. More surveys are needed to calculate an appropriate chinook estimate. Generally, a minimum of three swims is required to generate an independent chinook estimate.

FIRST NATIONS FOOD FISHERY

Catch estimation procedures developed by the Cowichan Tribes Aboriginal Fisheries Management unit have not been assessed by stock assessment staff. As a result, no comments can be made regarding the methodologies used. The current food fishing estimate of 320 chinook is a considerable decrease over 2003 estimates (Table 5, Figure 4).

BIOLOGICAL DATA

Male and jack chinook collected by the hatchery for broodstock were statistically different in mean length than the carcasses recovered on the spawning ground. Differences may be attributed to varying collection methods with the mark-recapture obtaining dead chinook from river pools and banks, while broodstock collection employs tangle-nets and beach seines. The lengths variations in males and jacks may be a combination of two factors: characteristics used in differentiating between male and jack chinook and the method of collection used to obtain

chinook. During carcass mark-recapture and broodstock collection the definition of a jack chinook is based on morphological characteristics of which judgement can vary by individual sampler. These characteristics can include, sex, body shape (i.e. slender or fat), and size. Alternatively, there was no significant difference in mean lengths of females from the carcass mark-recapture or from broodstock collection.

Statistical analysis revealed differences in the adipose fin clipped rates of both male and female chinook collected from the spawning grounds or those collected for hatchery broodstock. An adipose clip rate comparison between video analysis, hatchery broodstock, and spawning ground carcasses also yielded statistical differences. By separating the analysis to include only video analysis and carcass mark-recapture and then only video analysis and broodstock collection, it was hoped that the video data would support one method over the other; however, this did not occur. Video analysis is thought to be the most accurate method of collecting mark rate information because it eliminates biases associated with collection location, as all chinook are assumed to spawn above the fence; as well as selection biases.

MARK-RECAPTURE

The carcass mark-recapture portion of the Cowichan River chinook stock assessment project was implemented many years ago for several reasons. First, since handling fish at the fence site caused significant migration delays this practice was abandoned to ensure chinook reached the spawning grounds without undue stress. While length, age and sex data were collected by hatchery staff during broodstock capture, these data were not consistently representative of the spawning population. The sampling of carcasses from the spawning ground provided an additional source of biological data, which when pooled with the hatchery sample was more representative of the true population. Second, the recovery of coded-wire tags from hatchery broodstock did not provide an adequate sample size for a rigorous assessment. Spawning ground carcass recoveries yield additional coded-wire tagged fish. Finally, since high flows in past years have caused fence damage that resulted in incomplete enumeration of spawners, an additional method of providing a population estimate was required.

Population estimates for adult and jack chinook were determined using the pooled Petersen estimator. Since the true population size was not known, a direct measure of the accuracy of the estimates was not possible. However, an assessment of the underlying assumptions of equal probability of capture, simple random recovery sampling and complete mixing can usually be made by testing recovery and application samples for temporal, spatial, sex and size related biases (Schubert 2000). To carry out most of the bias assessments, different gear types must be utilized for capturing the tag application and the recovery samples. In the current study, the spawning ground carcass recovery was used to obtain both samples thus limiting the ability to assess sample biases.

No significant temporal biases were detectable for male and female chinook for application or recovery samples. This suggests temporal bias was not a factor in 2004. The recovery and application periods were chosen by actual calendar weeks, as sampling occurs on weekdays. In previous years, there were very few tagged carcasses available for recovery in the

early period and as the number of tags in the population accumulated tag incidence in the later periods was higher.

No sex related bias was evident in the application or recovery samples for adult chinook; however, when jacks were included in the assessment both samples showed significant bias. This is likely due to the size difference between adult and jack chinook, which affects the way carcasses behave in the river. Since jack carcasses are much smaller, they are more easily flushed out of the recovery area by small increases in river flow. As a result, they are less likely to be recovered than adult chinook carcasses.

Size bias testing did not provide an assessment of the size selectivity of the sampling method since both application and recovery samples were obtained using the same method. Rather, the size bias assessment provided an evaluation of the recoverability, based on size, of tagged carcasses that were redistributed back into the river after tagging. Testing revealed that there was no size bias for male, female or jack chinook.

Bias associated with location was not tested due to insufficient sample size in the middle section of the river. This may have been due to cloudy water conditions making carcass recoveries difficult, although some carcasses were found along the sides of the river. Erosion of clay banks, which exist in this segment of the river, causes the water to be very cloudy and substantially reduces water visibility. Conditions for recovering carcasses further deteriorate as water flow increases. Although location bias could not be tested, marked fish have been recovered by sports fisherman well downstream of the study area. This suggests some tagged specimens were not available for recapture and were probably flushed out of the study area due to higher than average water flow (Figure 5). A reduction in the ability to recapture tagged carcasses would contribute to an overestimation of the actual chinook population.

The detection of sampling biases usually results in the use of a stratified estimator; however, Schubert (2000) compared the performance of several mark-recapture population estimators for a sockeye salmon population of known abundance and concluded that the pooled Petersen estimator was less biased and preferred over stratified estimators. In that study, the Schaeffer estimator would not improve accuracy and it was recommended that the method be abandoned for use in population estimation. Also, it was determined that while the maximum likelihood Darroch estimator could potentially improve accuracy there was no obvious way of selecting between accurate and highly biased estimates. Parken and Atagi (2000) found that pooled and stratified estimators of Nass River summer steelhead produced similar escapement estimates but that the pooled estimator was more precise and had less statistical bias than the stratified estimator. These findings highlight the robust nature of the pooled Petersen estimator and suggest that its usage in determining population abundance from mark-recapture data is generally appropriate under a wide range of circumstances.

WATER MANAGEMENT PLAN

Due to plenty of rainfall in the second half of September and throughout October water conservation at the Cowichan Lake Weir was less of a concern than usual. This allowed the new fence design to be tested under various controlled discharge levels. It was determined that 22.65

m^3/s (800 ft^3/s) was the maximum discharge the new fence design can withstand while being safely operated and still functioning properly. This discharge rate is very dependant on floating debris within the river, such as logs, stumps, and large amounts of leaves. If too much floating debris collects on the fence panels, portions of the fence will become submerged allowing uncounted fish to swim upstream. Larger debris, such as logs and stumps, can cause serious damage to the fence panels and the counting tower.

As Cowichan Lake approaches maximum capacity, knowledge of the maximum output discharge becomes important in maintaining control of the weir. If water cannot be released from the weir before maximum capacity is reached, water will spill over the weir and river discharge can no longer be controlled. Scheduled lower discharge levels have been successful in facilitating fence removals.

Fish movement during 2004 was more spread out into various smaller peaks when compared to the previous five years. This is most likely due to a difference in weather conditions which allowed for a more continuous release of water rather than the traditional pulse release. When possible a continuous water release would be preferred as fish would be able to reach spawning areas uninhibited and with less stress induced by holding in the lower river.

SEAL PREDATION

Although seal predation was not directly assessed in this study, it is worthwhile to examine the impact seals have on chinook in Cowichan Bay. In 1988, the number of seals gradually increased from a low of 30 in April to a peak of about 100 in December. According to Olesiuk et al. (1990) harbour seals consume an estimated 9 tonnes of salmon annually in Cowichan Bay. An estimated 23% (September) to 48% (November) of the harbour seals' diet in Cowichan Bay was comprised of salmon (Bigg et al. 1990). Based on these data, consumption of chinook salmon could potentially range from 100 to 500 adults. These data were collected in 1988 when low flows in the Cowichan River persisted until the end of October. Predation likely increases the longer chinook salmon remain in the estuary waiting for high water to allow upstream migration. Fishery Officers' observations indicated that seal and sea lion populations have remained constant for the last couple of years in Cowichan Bay. As a result, predation on chinook was estimated to be approximately 300 adults.

POPULATION ESTIMATE

The 2004 Cowichan River chinook population estimate was based on an extrapolated fence count. High river flows resulted in the fence project being discontinued early and the chinook estimate was expanded using a Cowichan River run timing curve derived from previous fence data. The estimated number of natural spawning adult chinook migrating past the fence site of 2,226 was slightly above the 95% confidence limits (1606 – 2190) of adult chinook mark-recapture estimate. This result is consistent with past projects (Nagtegaal and Carter 1998, 2000, Nagtegaal et al. 2004) which have fence estimates above mark-recapture estimates. Since the mark-recapture study was conducted in the upper river only (the main spawning area) any

chinook that spawned in other areas of the watershed were not included, therefore this estimate would not include all chinook migrating past the fence.

The estimated 3,341 adult spawners was the third lowest since 1975, considerably below the 1975-2004 average of 5,205 and well below the revised escapement goal of 7,400 (Riddell et al. 2000) (Table 22, Figure 7). Hatchery releases of chinook fry were 2.41 million in brood year 2000, 3.23 million in brood year 2001, 1.94 million in brood year 2002, and 1.64 million in brood year 2003 (Figure 8). The enhanced contribution was calculated to be 32.1% of the total adult chinook return. This estimate is thought to be biased high due to the small number of carcasses recovered in the mark-recapture portion of this study coupled with large expansion factors for marked to unmarked fry release ratios. Hatchery and natural contributions for Cowichan River chinook escapement are summarized by year in Figure 9.

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Table 1. Daily counts at the Cowichan River fence site, 2004.

Date	Visibility[1]	Temp (°C)	Depth (cm)	Chinook		Coho		Chum	Pink	Unkn
				Adult	Jack	Adult	Jack			
10-Sep	1	15.0	46.0	2	1	0	0	0	0	0
11-Sep	2	16.3	47.3	7	0	0	0	0	0	0
12-Sep	1	17.0	46.3	4	1	0	0	0	0	0
13-Sep	1	15.3	45.0	2	5	0	0	0	0	0
14-Sep	1	16.3	43.3	2	4	0	0	0	0	0
15-Sep	1-2	15.3	49.0	1	9	0	0	0	0	0
16-Sep	1-2	13.7	54.0	18	15	0	1	0	0	0
17-Sep	1	14.0	55.7	113	47	0	1	0	0	0
18-Sep	1-2	14.0	56.7	170	63	0	0	0	0	0
19-Sep	1	12.3	55.3	12	4	0	0	0	0	0
20-Sep	1	13.3	53.7	16	9	0	1	0	0	0
21-Sep	1	14.7	52.3	34	21	0	0	0	0	0
22-Sep	1	15.0	52.0	5	2	0	0	0	0	0
23-Sep	1	14.3	52.0	5	6	0	0	0	0	0
24-Sep	1	13.3	55.3	53	46	6	4	0	0	0
25-Sep	1-2	14.0	64.7	405	239	15	6	0	0	0
26-Sep	1	14.0	65.0	47	24	3	1	0	0	1
27-Sep	1-2	15.7	65.0	53	27	0	0	0	0	0
28-Sep	1-2	15.7	63.3	16	17	0	0	0	0	0
29-Sep	1-2	15.3	64.7	16	15	3	2	4	0	0
30-Sep	1-2	14.3	65.0	30	20	4	4	0	0	1
1-Oct	1	15.0	65.0	26	8	5	3	1	0	0
2-Oct	1	15.3	65.0	24	18	10	3	0	0	0
3-Oct	1	14.7	65.7	18	5	3	0	1	0	0
4-Oct	1	15.7	67.0	10	6	8	4	0	0	1
5-Oct	1-2	15.7	66.7	47	11	18	5	2	0	0
6-Oct	2	16.0	66.0	136	76	35	34	1	0	2
7-Oct	1	15.0	67.3	11	4	9	2	0	0	2
8-Oct	1-2	14.3	72.3	53	30	22	9	8	1	0
9-Oct	1-2	14.0	79.0	131	49	114	38	3	0	0
10-Oct	1	15.0	73.0	57	24	42	22	1	0	0
11-Oct	1	15.3	70.0	3	3	7	6	2	0	0
12-Oct	1	16.0	69.0	17	11	16	12	2	0	0
13-Oct	1	14.3	70.0	25	5	28	11	2	0	0
14-Oct	1	15.7	74.7	26	4	124	22	11	0	0
15-Oct	1	15.3	77.0	23	7	122	20	7	0	0
16-Oct	1	15.0	75.7	7	3	104	20	3	0	0
17-Oct	1	15.3	78.0	32	5	178	92	39	1	1
18-Oct	1	14.0	80.0	118	34	831	73	65	0	8
19-Oct	1-2	13.0	83.3	36	35	917	84	276	0	2
20-Oct	1-2	13.7	85.0	47	22	1231	61	346	0	3
21-Oct	1	13.7	80.3	10	7	132	13	64	0	0
22-Oct	1	15.7	78.7	5	3	65	14	70	0	0
23-Oct	1	13.3	78.3	4	3	111	11	78	0	0

Table 1. (continued).

Date	Visibility[1]	Temp (°C)	Depth (cm)	Chinook Adult	Chinook Jack	Coho Adult	Coho Jack	Chum	Pink	Unkn
24-Oct	1	13.3	77.7	3	2	111	24	142	0	0
25-Oct	1-2	13.3	79.3	20	11	343	48	529	1	0
26-Oct	1-2	12.0	84.0	56	14	831	85	3867	0	0
27-Oct	1	12.0	82.5	46	28	790	88	1351	0	0
Totals				2002	1003	6238	824	6875	3	21

[1] Visibility Code: 1 = clear
2 = cloudy.

Table 2. Counts, by time interval, at the Cowichan River fence, 2004.

Time Period	Chinook Adult Count	Chinook Adult %	Chinook Jack Count	Chinook Jack %	Coho Adult Count	Coho Adult %	Coho Jack Count	Coho Jack %	Chum Count	Chum %
0000 - 0100	31	1.5	24	2.4	68	1.1	17	2.1	65	0.9
0100 - 0200	39	1.9	15	1.5	120	1.9	35	4.2	107	1.6
0200 - 0300	37	1.8	22	2.2	72	1.2	24	2.9	73	1.1
0300 - 0400	59	2.9	46	4.6	65	1.0	29	3.5	65	0.9
0400 - 0500	61	3.0	51	5.1	87	1.4	23	2.8	75	1.1
0500 - 0600	33	1.6	28	2.8	62	1.0	19	2.3	73	1.1
0600 - 0700	58	2.9	46	4.6	71	1.1	8	1.0	95	1.4
0700 - 0800	190	9.5	112	11.2	129	2.1	34	4.1	160	2.3
0800 - 0900	444	22.2	179	17.8	749	12.0	85	10.3	907	13.2
0900 - 1000	187	9.3	81	8.1	346	5.5	20	2.4	209	3.0
1000 - 1100	90	4.5	42	4.2	627	10.0	56	6.8	1202	17.5
1100 - 1200	107	5.3	41	4.1	874	14.0	34	4.1	758	11.0
1200 - 1300	142	7.1	42	4.2	764	12.2	54	6.6	562	8.2
1300 - 1400	60	3.0	19	1.9	519	8.3	31	3.8	427	6.2
1400 - 1500	99	4.9	47	4.7	372	6.0	84	10.2	463	6.7
1500 - 1600	60	3.0	28	2.8	309	5.0	67	8.1	400	5.8
1600 - 1700	90	4.5	43	4.3	271	4.3	57	6.9	395	5.7
1700 - 1800	56	2.8	34	3.4	254	4.1	42	5.1	375	5.5
1800 - 1900	44	2.2	24	2.4	243	3.9	30	3.6	174	2.5
1900 - 2000	14	0.7	11	1.1	34	0.5	6	0.7	68	1.0
2000 - 2100	10	0.5	5	0.5	82	1.3	10	1.2	56	0.8
2100 - 2200	23	1.1	13	1.3	41	0.7	18	2.2	26	0.4
2200 - 2300	33	1.6	22	2.2	25	0.4	18	2.2	64	0.9
2300 - 2400	35	1.7	28	2.8	57	0.9	23	2.8	76	1.1
Total	2002	100	1003	100	6241	100	824	100	6875	100

Table 3. Chinook mark rate from enumeration fence video, Cowichan River, 2004.

Date	Time	Unmarked Chinook		Marked Chinook		Unknown Chinook	
		Adult	Jack	Adult	Jack	Adult	Jack
6-Oct	0800-1043	66	25	2	4	1	8
8-Oct	1405-1630	28	14	2	1	8	18
18-Oct	1330-1715	19	3	2	0	1	0
Total		113	42	6	5	10	26
Mark Rate		5.04%	10.64%				

Table 4. Visual survey data collected for the Cowichan River, 1981-2003.

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1981	S	Sept. 12	175		208	1000	2-4
	S	Oct. 2	103		93	1500	2-4
	S	14	364		1160	4000	2-4
	H	22			2000		1-7
	S	23			3200	5000	2-4
Estimate for Season[3]						5500	
1982	S	Sept. 14	199		131	600	2-4
	S	Oct. 13			153		2-4
	H	19	saw few fish on spawning grounds				1-13
	F	Nov. 8				4000	
Estimate for Season						4500	
1983	S	Sept. 8	38		61	254	2-6
	S	15	62		121	504	2-6
	S	28	190		470	1838	1-2
	S	Oct. 7	207		425	1804	2-6
	S	14	802		997	2836	2-7
	S	25	901		1113	4500	1-6
Estimate for Season						4500	
1984	S	Aug. 28	80		84	400	2-5
	S	Sept. 6	25		72		
	S	13	79		80		3-11
	S	19	35		71		2-6
	S	26	291		434		2-6
	S	Oct. 3	205		283		3-7
	S	"	206		282	2200	8-11
	S	23	525		1300	5000	1-6
	S	Nov. 1	350		1276		1-6
Estimate for Season						5000	

Table 4. (continued)

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1985	S	Sept. 12	39		46	220	2-6
	S	17	42		10		12-13
	S	18	210		33		2-6
	S	27	245		104	456	2-6
	S	Oct. 3	244		99	360	2-6
	S	10	285		219		2-6
	S	16	293		347		2-6
	S	31	229		934	3500	1-6
Estimate for Season						3500	
1986	S	Sept. 9	295		85	300	2-6
	S	18	46		29	300	3-6
	S	24	161		56	350	12-13
	S	Oct. 7	1310		223	1000	2-6
	S	29	613		473	1200	1-6
	S	Nov. 6	1178		491	1200	
	H	8			515		1-13
Estimate for Season						1200	
1987	S	Sept. 9	30	300	10	50	3-8
	S	17	111		16	75	2-6
	S	25	112		16	75	3-6, 11-12
	S	Oct. 6	196	800	115	400	2-6
	S	15	196		96		1-6
	H	16		saw very few spawners			1-13
	S	28	417		468		1-6
	S	Nov. 6	329		649		1-6
Estimate for Season						1200	
1988	S	Aug. 25	100		50		2-6
	S	Sept. 1	271		149	700	2-6
	S	23	1464		271	1000	2-6
	S	Oct. 3	821	1600	1094	3500	2-6
	S	14	2008		2076	4000	1-6
Estimate for Season						5500	
1989	S	Sept. 11	151		58	300	2-6
	S	21	95		39	350	3-6
	S	Oct. 5	95		48	700	2-3
	S	18	719		350	1200	2-6
	S	Nov. 1	1537		2267		2-6
Estimate for Season						5000	
1990	S	Aug. 29	254		54	250	2-6
	S	Sept. 14	385		89	1000	3-6
	S	27	3169		477	2200	2-3
	S	Oct. 19	4297		2382	5000	2-6
Estimate for Season						5300	

Table 4. (continued)

				Chinook				
				Jacks		Adults		
	Method[1]	Date		Count	Estimate	Count	Estimate	River Segment[2]
1991	S	Sept.	19			1882	6000	2-6
	S	Oct.	2			2873	7500	2-6
	S		17			2924	8700	2-6
	S		31			3502[4]	9000	2-6
Estimate for Season							10000	
1992	S	Sept.	16	5		8		2-5
	S	Oct.	2	124		46	200	2-6
	S		15	359		291	700	2-6
	S		15	113		162		2-6
	S		27	514		797	2000	1-6
	S		28	591		767		1-6
	S	Nov.	13	506		467		1-6
	S		13	450		640[5]		1-6
Estimate for Season							7500	
1993	S	Sept.	23	23		14	47	2-6
	S		30	81		62	210	2-6
	S	Oct.	14	207		199	676	2-6
	S		28	127		327	1111	2-6
	S	Nov.	4	480		987	3355	
Estimate for Season[6]							5200	
1994	S	Aug.	24	39		3		2-6
	S	Sept.	14	67		46	156	2-6
	S		28	421		323	1098	2-6
	S	Oct.	13	1253		1146	3896	2-6
	S		26	442		1450	4930	2-6
Estimate for Season[6]							5500	
1995	S	Sept.	28	294		267	1170	2-6
	S	Oct.	25	490		1798	6653	2-6
Estimate for Season[6]							15500	
1996	S	Sept.	13	45		46	147	2-6
	S		26	166		150	510	2-6
	S	Oct.	2	254		534	1815	2-6
	S		9	579		1157	3933	2-6
	S		15	195		707	2403	2-6
	S		22	557		1699	5776	2-6
Estimate for Season[6]							6500	
1997	S	Sept.	23	165		358	1217	2-6
	S	Sept.	25	87		404	1373	2-6
	S	Sept.	30	54		509	1730	2-6
	S	Oct.	16	84		289	980	2-6
	S	Oct.	23	1036		1831	6225	2-6
Estimate for Season[5]							6500	

Table 4. (continued)

				Chinook				
				Jacks		Adults		
	Method[1]	Date		Count	Estimate	Count	Estimate	River Segment[2]
1998	S	Sept.	25	72		37		2-6
	S	Oct.	13	54		53		2-6
	S	Oct.	20	130		857	2913	2-6
	S	Oct.	26	317		1260	4284	2-6
Estimate for Season							4284	
1999	S	Sept.	10	88		46	221	2-6
	S	Oct.	13	321		342	1641	2-6
Estimate for Season							4500	
2000	S	Sept.	13	33		25	N/A[7]	2-6
Estimate for Season							3069	
	S	Sept.	26	80		230	782	Lower[8]
	S	Oct.	19	439		940	3196	1-6
2001	S	Oct.	23	135		255	867	2-6
Estimate for Season							3282	
2002	S	Oct.	25	111		418	1421	2-3
Estimate for Season							2505	
2003	Not Available.							
Estimate for Season							2494	
2004	S	Oct.	7	25		58	197	1-6
Estimate for Season							2226	

[1]S - Swim survey, H - Helicopter survey, F - boat survey
[2]Refer to Figure 1.
[3]Total escapement estimate for adult chinook.
[4]516 chinook carcasses were counted in this total.
[5]28 chinook carcasses were counted in this total.
[6]Swim surveys conducted by Cowichan Tribes River Management Unit, total escapement determined by Fishery officers.
[7]Adult population estimate based on swim survey records was not feasible due to extremely low water conditions during swim survey.
[8]Swim survey took place in the lower Cowichan River from Black Bridge to Green Point (Figure 2).

Table 5. Annual adult and jack chinook catch estimates from the Cowichan River First Nations food fishery[1], 1981-2003.

Year[2]	Chinook Catch	
	Adult	Jack[3]
1971	725	
1972	700	
1973	900	
1974	1000	
1975	900	
1976	1000	
1977	1000	
1978	500	
1979	500	
1980	1500	
1981	1500	1500
1982	1000	1000
1983	250	1000
1984	355	700
1985	1000	1000
1986	800	800
1987	800	800
1988	681	450
1989	1055	250
1990	820	150
1991	450	70
1992	900	12
1993	650	22
1994	700	227
1995	533	120
1996	810	150
1997	191	N/A
1998	1073	N/A
1999	233	89
2000	89	N/A
2001	918	120
2002	1500	N/A
2003	825	N/A
2004	320	4

[1] Includes chinook caught in both the spear fishery and the in-river gillnet fishery.

[2] Since 1988, data have been collected by the Cowichan Tribes River Management Unit. Prior to 1988, data were collected by local Fishery Officers.

[3] Estimates for jack chinook were not provided in 1997, 1998, 2000, 2002 and 2003.

Table 6. Daily summary of chinook broodstock collected by the Cowichan River hatchery during 2004.

Date	Below Fence			Above Fence		
	Male	Female	Jack	Male	Female	Jack
27-Sep	22	14	0	-	-	-
28-Sep	57	55	0	-	-	-
29-Sep	25	31	0	-	-	-
30-Sep	45	40	0	-	-	-
1-Oct	25	21	0	-	-	-
4-Oct	0	3	0	-	-	-
5-Oct	12	10	0	-	-	-
6-Oct	27	13	0	-	-	-
7-Oct	23	21	11	-	-	-
8-Oct	6	5	4	-	-	-
12-Oct	13	4	4	-	-	-
13-Oct	1	22	1	-	-	-
19-Oct	-	-	-	1	-	-
28-Oct	-	-	-	-	5	-
29-Oct	-	-	-	2	2	-
1-Nov	-	-	-	-	8	-
3-Nov	-	-	-	16	16	-
4-Nov	-	-	-	1	16	-
5-Nov	-	-	-	-	6	-
9-Nov	-	-	-	-	2	-
10-Nov	-	-	-	1	4	-
Total	256	239	20	21	59	0

Note: all chinook captured above the fence site were taken at Skutz Falls.

Table 7. Annual Cowichan River Hatchery broodstock collection of adult and jack chinook, 1981-2004.

Year	Chinook Broodstock Collection	
	Adult	Jack[1]
1981	282	
1982	534	
1983	242	
1984	278	
1985	175	
1986	315	
1987	582	
1988	678	30
1989	535	96
1990	327	1
1991 [2]	1755	347
1992	1850	77
1993	2200	228
1994	1357	145
1995	2149	512
1996	1615	258
1997	125	79
1998	1485	201
1999	1659	1
2000	1529	14
2001	1732	0
2002	1480	0
2003 [3]	862	14
2004	575	20

[1] Barry Cordecedo (Salmonid Enhancement Program) provided numbers on broodstock collection from 1981 to 1987. The broodstock numbers provided included jacks, but no reliable records were kept. It was estimated that for most years about 10 to 15 jacks were collected. These estimates were subtracted from the broodstock numbers resulting in an estimate of the number of adult chinook removed from the system.

[2] In addition, 284 males were removed for broodstock but later returned to the river.

[3] In Addition, 22 males and 86 females were removed for broodstock but later returned to the river.

Table 8. Summary of age by sex for Cowichan River chinook collected from the hatchery broodstock during 2004.

European Age[1]	Total Age	Male		Female		Total Adult		Jack		Total	
		#	%	#	%	#	%	#	%	#	%
01	2	2	6.3%	1	1.6%	3	3.2%	8	100.0%	11	10.8%
02	3	27	84.4%	28	45.2%	55	58.5%	0	0.0%	55	53.9%
03	4	2	6.3%	29	46.8%	31	33.0%	0	0.0%	31	30.4%
04	5	1	3.1%	4	6.5%	5	5.3%	0	0.0%	5	4.9%
Total		32	100%	62	100%	94	100%	8	100%	102	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Total number of unreadable scales: 13

Table 9. Length-frequency of chinook sampled on the Cowichan River spawning grounds, 2004.

Length (cm)	Male	Female	Jack
23	0	0	1
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	1
29	0	0	0
30	0	0	1
31	0	1	2
32	0	0	1
33	0	0	0
34	0	0	5
35	0	0	5
36	1	0	15
37	1	0	10
38	0	0	12
39	0	1	14
40	1	0	15
41	1	0	8
42	0	0	7
43	0	0	7
44	0	0	5
45	0	0	5
46	0	0	3

Table 9. (continued)

Length (cm)	Male	Female	Jack
47	0	0	7
48	0	0	4
49	0	0	3
50	3	3	0
51	6	2	0
52	3	0	0
53	6	3	0
54	12	3	0
55	6	6	0
56	13	10	0
57	11	12	0
58	14	6	1
59	18	8	0
60	9	10	0
61	14	11	0
62	7	8	0
63	11	3	0
64	6	12	0
65	4	8	0
66	10	15	0
67	3	15	0
68	6	17	0
69	2	14	0
70	8	19	0
71	3	10	0
72	3	6	0
73	4	4	0
74	5	9	0
75	1	2	0
76	0	1	0
77	2	7	0
78	0	1	0
79	1	2	0
80	0	2	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	1	0
Total	195	232	132
Mean Length (cm)	60.6	65.0	39.9
Standard Deviation (cm)	7.2	7.3	4.8
Adipose Fin Clips	3	8	5
Fin Clip Rate	1.5%	3.4%	3.8%

Table 10. Summary of age by sex for Cowichan River chinook collected from the spawning grounds during 2004.

European Age[1]	Total Age	Male		Female		Total Adult		Jack		Total	
		#	%	#	%	#	%	#	%	#	%
00	1	0	0.0%	0	0.0%	0	0.0%	1	1.6%	1	0.3%
01	2	3	2.5%	1	0.7%	4	1.6%	59	92.2%	63	19.6%
02	3	80	66.7%	40	29.2%	120	46.7%	4	6.3%	124	38.6%
11	3	1	0.8%	0	0.0%	1	0.4%	0	0.0%	1	0.3%
03	4	29	24.2%	82	59.9%	111	43.2%	0	0.0%	111	34.6%
04	5	7	5.8%	13	9.5%	20	7.8%	0	0.0%	20	6.2%
05	6	0	0.0%	1	0.7%	1	0.4%	0	0.0%	1	0.3%
Total		120	100%	137	100%	257	100%	64	100%	321	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Total number of unreadable scales: 105

Table 11. Length-frequency of chinook broodstock collected by the Cowichan River Hatchery, 2004.

Length (cm)	Male	Female	Jack
35	0	0	1
36	0	0	0
37	0	0	0
38	0	0	0
39	0	0	0
40	0	0	1
41	0	0	1
42	0	1	0
43	1	0	0
44	0	0	1
45	0	0	1
46	0	0	2
47	0	0	0
48	0	0	0
49	1	0	0
50	1	0	0
51	1	0	1
52	0	0	0
53	0	0	0
54	2	0	0
55	3	2	0
56	8	2	0
57	2	3	0

Table 11. (continued)

Length (cm)	Male	Female	Jack
58	1	2	0
59	3	2	0
60	2	5	0
61	4	7	0
62	1	1	0
63	1	6	0
64	1	2	0
65	0	5	0
66	1	5	0
67	0	2	0
68	0	2	0
69	0	5	0
70	0	3	0
71	0	2	0
72	0	5	0
73	0	1	0
74	0	3	0
75	0	2	0
76	0	3	0
77	0	1	0
78	0	0	0
79	0	1	0
80	0	0	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0
86	1	0	0
Total	34	73	8
Mean Length (cm)	57.7	65.3	43.3
Standard Deviation (cm)	6.8	6.7	4.8
Adipose Fin Clips	4	9	3
Fin Clip Rate	11.8%	12.3%	37.5%

Table 12. Release and recovery data for coded-wire tags recovered from Cowichan River chinook sampled on the spawning grounds during 2004.

Recovery Data					Release Data			
Date (dd/mmm)	Location	Adipose Clipped	POH Length (mm)	Sex	Brood Year	Tag Code	Location [1]	Date (dd/mm/yy)
08-Nov-04	16	a	620	2	2001	18-46-41	COWICHAN R (early)	11-Apr-02
09-Nov-04	21	a	577	1	2001	18-46-39	COWICHAN R (early)	11-Apr-02
12-Nov-04	9	a	650	2	2001	18-45-39	COWICHAN R (early)	11-Apr-02
15-Nov-04	23	a	630	2	2001	18-46-43	COWICHAN R (late)	16-May-02
16-Nov-04	14	a	754	2	1999	18-31-20	COWICHAN R (early)	07-Mar-00
16-Nov-04	26	a	404	3	2002	18-50-15	COWICHAN R (late)	26-May-03
16-Nov-04	16	a	679	2		No Pin		
17-Nov-04	13	a	596	2	2000	18-32-17	COWICHAN R (late)	01-May-01
17-Nov-04	34	a	565	1	2001	18-46-44	COWICHAN R (late)	16-May-02
17-Nov-04	34	a	431	3	2002	18-50-52	Seapen	28-May-03
18-Nov-04	34	a	323	3		Lost Pin		
19-Nov-04	35	a	357	3	2002	18-50-14	COWICHAN R (late)	26-May-03
22-Nov-04	14	a		2	2000	63-06-76	Friday Creek, WA, USA	29-May-01
23-Nov-04	29	a	512	1	2001	18-44-48	Seapen	21-May-02
23-Nov-04	5	a	603	2	2001	18-46-44	COWICHAN R (late)	16-May-02
24-Nov-04	17	a	377	3		No Pin		

1 Cowichan Hatchery release strategies for chinook:

Upper Cowichan River (late): raised to pre-smolt size (5-6 g) prior to release approximately 3 km below the weir in May.

Upper Cowichan River (early): raised to fry (3 g) prior to release approximately 3 km below the weir in early April.

Cowichan Lake Pen: raised to pre-smolt size (5-6 g) prior to release just above the weir in May.

Hatchery (late): raised to pre-smolt size (5-6 g) prior to release at the hatchery in May.

Seapen: raised to smolt size (6+ g) prior to release from the netpens in Cowichan Bay in early June.

Table 13. Cowichan River Hatchery chinook release[1] data for brood years 1979-2003.

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site
021846	1979	31628	32134	98.4	2.8		1980/05/07	COWICHAN R
022060	1979	32034	32547	98.4	2.8		1980/05/07	SKUTZ FALLS
022158	1980	52519	65000	80.8	2.3		1981/06/09	COWICHAN R
022307	1981	30179	30373	99.4	3.1		1982/05/12	COWICHAN R
022339	1982	49135	224944	21.8	2.9		1983/05/14	SKUTZ FALLS
022831	1983	50613	101000	50.1	4.27		1984/05/25	KOKSILAH R
NOCN8311	1983		200000	0.0	4.27		1984/05/31	COWICHAN R
NOCN8411	1984		187823	0.0	4.8	1985/05/13	1985/05/14	COWICHAN R
023803	1985	25365	25804	98.3	4.26	1986/05/23	1986/05/24	COWICHAN R
023804	1985	25455	25895	98.3	4.26	1986/05/23	1986/05/24	COWICHAN R
023911	1985	11980	12187	98.3	4.26	1986/05/23	1986/05/24	COWICHAN R
NOCN8619	1986		321172	0.0	4	1987/05/13	1987/05/22	COWICHAN R
NOCN8620	1986		54608	0.0	3.48		1987/05/21	KOKSILAH R
024334	1987	14298	14334	99.7	3.41		1988/04/18	COWICHAN R
024729	1987	25360	25424	99.7	3.4		1988/04/18	COWICHAN R
024730	1987	25869	25934	99.7	3.4		1988/04/18	COWICHAN R
024731	1987	27428	27497	99.7	7.1	1988/04/18	1988/05/18	COWICHAN LK
024732	1987	27271	27339	99.8	7.1		1988/05/18	COWICHAN LK
024733	1987	26911	26978	99.8	7.1		1988/05/18	COWICHAN LK
024734	1987	23521	23580	99.7	7.1		1988/05/18	COWICHAN LK
024735	1987	26719	26786	99.7	3.4	1988/04/18	1988/05/18	COWICHAN R
024945	1987	26461	123361	21.5	7.49	1988/05/25	1988/05/26	COWICHAN R UP
024946	1987	26658	123560	21.6	7.49	1988/05/25	1988/05/26	COWICHAN R UP
024947	1987	26761	123663	21.6	7.49	1988/05/25	1988/05/26	COWICHAN R UP
025008	1987	26817	123720	21.7	7.49	1988/05/25	1988/05/26	COWICHAN R UP
024860	1988	25117	25243	99.5	3.66		1989/04/28	COWICHAN R
025012	1988	26595	54768	48.6	6.49		1989/05/21	COWICHAN R
025013	1988	25982	54154	48.0	6.49		1989/05/21	COWICHAN R
025015	1988	23058	24894	92.6	3.66		1989/04/28	COWICHAN R
025016	1988	26821	26821	100.0	3.66		1989/04/28	COWICHAN R
025017	1988	27611	28175	98.0	3.66		1989/04/28	COWICHAN R
025523	1988	27531	56123	49.1	6.49		1989/05/21	COWICHAN R
025524	1988	27205	55378	49.1	6.49		1989/05/21	COWICHAN R
025749	1988	26922	133331	20.2	6.06		1989/05/15	COWICHAN LK
025750	1988	27036	133446	20.3	6.06		1989/05/15	COWICHAN LK
025751	1988	23106	130107	17.8	6.06		1989/05/15	COWICHAN LK
025752	1988	26169	132842	19.7	6.06		1989/05/15	COWICHAN LK
020352	1989	28287	28573	99.0	3.4	1990/04/12	1990/04/12	COWICHAN R
020522	1989	27072	36800	73.6	6.53	1990/05/22	1990/05/23	COWICHAN R
020622	1989	27787	37242	74.6	6.53	1990/05/22	1990/05/23	COWICHAN R
020623	1989	28164	37619	74.9	6.53	1990/05/22	1990/05/23	COWICHAN R
020624	1989	28331	37786	75.0	6.53	1990/05/22	1990/05/23	COWICHAN R
020938	1989	28312	28312	100.0	3.4	1990/04/12	1990/04/12	COWICHAN R
020939	1989	26218	26218	100.0	3.4	1990/04/12	1990/04/12	COWICHAN R
026103	1989	27145	27145	100.0	3.4	1990/04/12	1990/04/12	COWICHAN R
026255	1989	26400	119674	22.1	7.19		1990/05/14	COWICHAN LK

Table 13. (continued)

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site
026256	1989	25693	119497	21.5	7.19		1990/05/14	COWICHAN LK
026257	1989	25790	119325	21.6	7.19		1990/05/14	COWICHAN LK
026258	1989	25219	118748	21.2	7.19		1990/05/14	COWICHAN LK
020333	1990	25687	94172	27.3	8.43	1991/05/15	1991/05/15	COWICHAN LK
020334	1990	25898	94384	27.4	8.43	1991/05/15	1991/05/15	COWICHAN LK
020335	1990	25739	94224	27.3	8.43	1991/05/15	1991/05/15	COWICHAN LK
020336	1990	27135	27135	100.0	3.31	1991/04/17	1991/04/17	COWICHAN R
020337	1990	26631	26631	100.0	3.31	1991/04/17	1991/04/17	COWICHAN R
020338	1990	27046	27046	100.0	3.31	1991/04/17	1991/04/17	COWICHAN R
020339	1990	26721	34318	77.9	6.4	1991/05/21	1991/05/22	COWICHAN R
020340	1990	26993	34592	78.0	6.4	1991/05/21	1991/05/22	COWICHAN R
020341	1990	26533	33995	78.0	6.4	1991/05/21	1991/05/22	COWICHAN R
020342	1990	25437	92182	27.6	4.75	1991/06/17	1991/06/18	COWICHAN R
020343	1990	25391	92136	27.6	4.75	1991/06/17	1991/06/18	COWICHAN R
NOCN9044	1990		5086	0.0	5.41	1991/06/26	1991/06/26	COWICHAN ESTUARY
180513	1991	26972	336330	8.0	5.04	1992/05/17	1992/05/17	COWICHAN LK
180514	1991	25964	335584	7.7	5.04	1992/05/17	1992/05/17	COWICHAN LK
180515	1991	27694	254287	10.9	4.01	1992/04/21	1992/04/22	COWICHAN R LOW
180516	1991	27148	254015	10.7	4.01	1992/04/21	1992/04/22	COWICHAN R LOW
180517	1991	27471	505110	5.4	5.47	1992/05/19	1992/05/21	COWICHAN R UP
180518	1991	27277	504916	5.4	5.47	1992/05/19	1992/05/21	COWICHAN R UP
180519	1991	27432	160695	17.1	3.75	1992/04/21	1992/04/22	COWICHAN R LOW
180520	1991	27001	160262	16.8	3.75	1992/04/21	1992/04/22	COWICHAN R LOW
180521	1991	26871	27444	97.9	6.29	1992/05/29	1992/05/29	COWICHAN ESTUARY
180522	1991	26852	27424	97.9	6.29	1992/05/29	1992/05/29	COWICHAN ESTUARY
NOCN9145	1991		513053	0.0	5.69	1992/05/19	1992/05/20	COWICHAN R UP
180209	1992	24770	98974	25.0	6.3	1993/05/25	1993/05/25	COWICHAN ESTUARY
180210	1992	26383	327416	8.1	5.86	1993/05/17	1993/05/19	COWICHAN R UP
180550	1992	25311	326344	7.8	5.86	1993/05/17	1993/05/19	COWICHAN R UP
181042	1992	53620	412953	13.0	6.52	1993/05/25	1993/05/25	COWICHAN R
181043	1992	54235	901937	6.0	5.64	1993/05/10	1993/05/10	COWICHAN LK
181044	1992	55027	907719	6.1	3.56	1993/04/07	1993/04/07	COWICHAN R UP
021211	1993	24875	103900	23.9	6.17	1994/05/25	1994/05/25	SEAPEN
181319	1993	49966	1001002	5.0	6.29	1994/05/05	1994/05/05	COWICHAN LK
181320	1993	50420	684279	7.4	3.79	1994/04/18	1994/04/18	COWICHAN R UP
181321	1993	50045	652354	7.7	6.11	1994/05/18	1994/05/18	COWICHAN R UP
181322	1993	50285	490079	10.3	6.06	1994/05/24	1994/05/24	COWICHAN R
181329	1994	25023	103815	24.1	6.08	1995/05/31	1995/05/31	SEAPEN
181436	1994	50133	100252	50.0	5.44	1995/05/30	1995/05/30	COWICHAN R
181437	1994	49962	418750	11.9	4	1995/05/02	1995/05/02	COWICHAN R UP
181438	1994	49610	939287	5.3	6.32	1995/05/15	1995/05/17	COWICHAN R UP
181439	1994	49846	101763	49.0	6.48	1995/05/25	1995/05/25	COWICHAN LK
182023	1995	25114	109088	23.0	6.76	1996/05/10	1996/05/10	SEAPEN
182024	1995	25653	297360	8.6	6.56	1996/05/06	1996/05/06	COWICHAN LK
182025	1995	24488	283856	8.6	6.56	1996/05/06	1996/05/06	COWICHAN LK
182026	1995	25183	355089	7.1	6.26	1996/05/07	1996/05/07	COWICHAN R UP
182027	1995	25218	355583	7.1	6.26	1996/05/07	1996/05/07	COWICHAN R UP

Table 13. (continued)

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site
182028	1995	25052	344597	7.3	3.47	1996/04/02	1996/04/02	COWICHAN R UP
182029	1995	25129	345657	7.3	3.47	1996/04/02	1996/04/02	COWICHAN R UP
182030	1995	25196	245910	10.2	6.37	1996/05/09	1996/05/09	COWICHAN R
182031	1995	25020	244193	10.2	6.37	1996/05/09	1996/05/09	COWICHAN R
182737	1996	25235	100196	25.2	6.79	1997/05/07	1997/05/07	COWICHAN BAY
182738	1996	25108	318583	7.9	5.44	1997/04/30	1997/04/30	COWICHAN LK
182739	1996	25205	319814	7.9	5.44	1997/04/30	1997/04/30	COWICHAN LK
182740	1996	25218	448340	5.6	6.29	1997/04/28	1997/04/29	COWICHAN R UP
182741	1996	25649	456002	5.6	6.29	1997/04/28	1997/04/29	COWICHAN R UP
182742	1996	25457	401644	6.3	3.34	1997/04/01	1997/04/01	COWICHAN R UP
182743	1996	25019	394733	6.3	3.34	1997/04/01	1997/04/01	COWICHAN R UP
182744	1996	25154	219780	11.4	5.89	1997/05/05	1997/05/05	COWICHAN R
182745	1996	25082	219151	11.4	5.89	1997/05/05	1997/05/05	COWICHAN R
182761	1997	25213	25213	100.0	3.68	1998/04/09	1998/04/09	COWICHAN R UP
182762	1997	25206	25206	100.0	3.68	1998/04/09	1998/04/09	COWICHAN R UP
182763	1997	25698	25698	100.0	3.68	1998/04/09	1998/04/09	COWICHAN R UP
182801	1997	24817	28209	88.0	6.47	1998/05/13	1998/05/13	COWICHAN R UP
182802	1997	24890	28282	88.0	6.47	1998/05/13	1998/05/13	COWICHAN R UP
182803	1997	24923	28316	88.0	6.47	1998/05/13	1998/05/13	COWICHAN R UP
182804	1997	24971	24971	100.0	6.46	1998/05/21	1998/05/21	COWICHAN R
182805	1997	25026	25026	100.0	6.46	1998/05/21	1998/05/21	COWICHAN R
183213	1997	24915	51754	48.1	6.27	1998/05/25	1998/05/25	SEAPEN
183107	1998	25163	224868	11.2	3.07	1999/03/31	1999/03/31	COWICHAN R UP
183108	1998	25201	225208	11.2	3.07	1999/03/31	1999/03/31	COWICHAN R UP
183109	1998	24803	132012	18.8	6.56	1999/05/10	1999/05/10	COWICHAN R UP
183110	1998	24927	132676	18.8	6.56	1999/05/10	1999/05/10	COWICHAN R UP
183111	1998	25163	75629	33.3	6.31	1999/05/10	1999/05/10	COWICHAN R
183112	1998	24875	74763	33.3	6.31	1999/05/10	1999/05/10	COWICHAN R
183726	1998	25135	356567	7.0	5.93	1999/05/07	1999/05/07	COWICHAN LK
183727	1998	25136	356568	7.0	5.93	1999/05/07	1999/05/07	COWICHAN LK
183728	1998	25234	225504	11.2	3.07	1999/03/31	1999/03/31	COWICHAN R UP
183729	1998	25087	224189	11.2	3.07	1999/03/31	1999/03/31	COWICHAN R UP
183730	1998	24867	132354	18.8	6.56	1999/05/10	1999/05/10	COWICHAN R UP
183731	1998	24921	132644	18.8	6.56	1999/05/10	1999/05/10	COWICHAN R UP
183732	1998	24959	75015	33.3	6.31	1999/05/10	1999/05/10	COWICHAN R
183733	1998	25024	75211	33.3	6.31	1999/05/10	1999/05/10	COWICHAN R
183734	1998	25127	99928	25.1	5.1	1999/05/17	1999/05/17	SEAPEN
183119	1999	24855	270757	9.2	3.19	2000/03/07	2000/03/07	COWICHAN R UP
183120	1999	24917	271436	9.2	3.19	2000/03/07	2000/03/07	COWICHAN R UP
183121	1999	24933	271609	9.2	3.19	2000/03/07	2000/03/07	COWICHAN R UP
183122	1999	25024	272601	9.2	3.19	2000/03/07	2000/03/07	COWICHAN R UP
183123	1999	24776	481197	5.1	6.58	2000/04/27	2000/04/28	COWICHAN R UP
183124	1999	24839	482428	5.1	6.58	2000/04/27	2000/04/28	COWICHAN R UP
183125	1999	25118	215385	11.7	6.99	2000/05/05	2000/05/05	COWICHAN R
183126	1999	25039	215306	11.6	6.99	2000/05/05	2000/05/05	COWICHAN R
183127	1999	25078	99936	25.1	8.66	2000/05/17	2000/05/17	SEAPEN
182811	2000	25175	99829	25.2	7.98	2001/05/23	2001/05/23	SEAPEN
183216	2000	25152	504558	5.0	6.55	2001/05/01	2001/05/01	COWICHAN R UP

Table 13. (continued)

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site
183217	2000	24833	503194	4.9	6.55	2001/05/01	2001/05/01	COWICHAN R UP
184539	2000	50166	338640	14.8	6.21	2001/05/03	2001/05/03	COWICHAN R
184546	2000	49972	481337	10.4	3.19	2001/03/19	2001/03/20	COWICHAN R UP
184547	2000	50054	482162	10.4	3.19	2001/03/19	2001/03/20	COWICHAN R UP
184448	2001	25163	96786	26.00	5.68	2002/05/21	2002/05/21	SEAPEN
184639	2001	25140	249911	10.06	3.5	2002/04/11	2002/04/11	COWICHAN R UP
184640	2001	25047	248987	10.06	3.5	2002/04/11	2002/04/11	COWICHAN R UP
184641	2001	25255	251054	10.06	3.5	2002/04/11	2002/04/11	COWICHAN R UP
184642	2001	24957	248092	10.06	3.5	2002/04/11	2002/04/11	COWICHAN R UP
184643	2001	25068	787409	3.18	5.68	2002/05/14	2002/05/15	COWICHAN R UP
184644	2001	25062	787221	3.18	5.68	2002/05/14	2002/05/15	COWICHAN R UP
184645	2001	25019	278423	8.99	5.28	2002/04/28	2002/04/28	COWICHAN R
184646	2001	25197	280404	8.99	5.28	2002/04/28	2002/04/28	COWICHAN R
184918	2002	50091	383156	13.07	4.5	2003/04/11	2003/04/11	COWICHAN R UP
184919	2002	50186	383877	13.07	4.5	2003/04/11	2003/04/11	COWICHAN R UP
185013	2002	24712	257226	9.61	5.74	2003/05/26	2003/05/26	COWICHAN R UP
185014	2002	25128	261555	9.61	5.74	2003/05/26	2003/05/26	COWICHAN R UP
185015	2002	25102	261282	9.61	5.74	2003/05/26	2003/05/26	COWICHAN R UP
185016	2002	25197	288668	8.73	6.0	2003/05/27	2003/05/27	HATCHERY
185052	2002	25134	99918	25.15	7.36	2003/05/28	2003/05/28	SEAPEN
185412	2003	25144	99887	25.17	6.54	2004/05/26	2004/05/26	SEAPEN
185660	2003	25111	197202	12.73	3.85	2004/04/05	2004/04/05	COWICHAN R UP
185661	2003	25110	197194	12.73	3.85	2004/04/05	2004/04/05	COWICHAN R UP
185662	2003	25124	197304	12.73	3.85	2004/04/05	2004/04/05	COWICHAN R UP
185663	2003	25051	196731	12.73	3.85	2004/04/05	2004/04/05	COWICHAN R UP
185701	2003	25168	219733	11.45	5.3	2004/05/20	2004/05/20	COWICHAN R UP
185702	2003	24863	219010	11.35	5.3	2004/05/20	2004/05/20	COWICHAN R UP
185703	2003	24987	219126	11.40	5.3	2004/05/20	2004/05/20	COWICHAN R UP
185704	2003	25029	98411	25.43	6.65	2004/05/11	2004/05/11	HATCHERY

[1] Cowichan River Hatchery release strategies for chinook:

Upper Cowichan River (late): raised to pre-smolt size (5-6 g) prior to release approximately 3 km below the weir in May.

Upper Cowichan River (early): raised to fry (3 g) prior to release approximately 3 km below the weir in early April.

Cowichan Lake Pen: raised to pre-smolt size (5-6 g) prior to release just above the weir in May.

Hatchery (late): raised to pre-smolt size (5-6 g) prior to release at the hatchery in May.

Seapen: raised to smolt size (6+ g) prior to release from the netpens in Cowichan Bay in early June.

Table 14. Cowichan River daily discharge[1] measured in cubic meters per second, for 2004.

	Month											
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	78.4	122	51.8	63.7	22.7	9.24	2.91	3.03	3.19	14.9	45.4	77.0
2	72.4	111	49.6	58.6	22.4	8.77	2.99	2.96	3.29	15.6	84.4	72.8
3	66.3	105	48.0	53.4	22.0	8.93	3.01	2.97	3.25	15.7	90.0	69.3
4	60.7	99.3	46.5	49.4	18.6	8.88	3.01	3.04	3.19	15.9	87.5	83.4
5	56.8	93.3	46.4	45.9	15.3	9.02	2.92	3.03	3.22	16.2	86.3	91.8
6	53.9	96.7	45.4	43.1	14.3	9.01	3.09	3.65	3.17	16.9	85.1	87.3
7	53.5	98.6	54.5	40.5	14.0	9.09	3.09	3.45	3.60	16.7	89.7	87.6
8	58.9	92.2	60.0	37.7	14.6	8.87	3.16	3.18	3.55	19.8	91.7	105
9	66.7	87.0	60.4	34.9	14.2	8.73	3.33	3.04	3.49	27.1	88.7	106
10	81.9	82.2	59.0	30.5	14.1	8.64	3.34	2.91	3.86	23.3	85.2	209
11	90.7	77.4	57.4	26.4	13.8	8.73	3.45	2.95	6.13	19.3	80.9	223
12	94.2	73.5	55.5	26.1	13.9	9.03	3.27	3.01	4.55	19.7	76.6	176
13	109	69.3	53.3	25.5	13.7	9.73	3.18	2.96	4.38	20.8	77.2	159
14	166	68.2	52	26.3	13.7	9.11	3.10	2.81	4.40	23.1	75.3	173
15	183	66.8	48.1	26.4	13.7	8.94	3.13	2.77	5.92	22.8	88.4	167
16	166	66.9	42.5	25.5	13.4	8.38	3.12	2.89	8.24	22.7	95.4	154
17	150	72.9	35.4	25.0	13.6	7.55	3.24	2.99	9.99	22.9	96.1	144
18	147	85.5	30.8	23.9	13.7	6.48	3.10	2.91	10.1	25.5	105	137
19	145	80.7	32.3	24.0	13.9	5.54	3.11	2.90	9.65	28.4	108	129
20	137	75.2	29.6	25.6	13.3	4.69	3.12	2.95	8.63	30.1	102	121
21	128	70.6	28.3	24.6	12.1	3.95	3.2	3.31	7.67	27.2	96.6	111
22	116	66.7	28.5	23.7	11.8	3.65	3.10	3.10	7.73	26.5	91.3	104
23	110	63.5	28.5	23.8	10.6	3.55	2.89	2.97	7.66	25.0	87.4	97.9
24	103	60.4	30.7	23.2	9.35	3.41	2.90	3.01	8.38	24.1	91.6	90.6
25	95.4	61.0	41.1	23.3	9.02	3.30	2.88	3.56	14.9	26.1	105	89.3
26	90.5	61.2	60.5	23.5	9.20	3.34	2.93	3.66	14.8	32.2	100	90.6
27	85.2	58.4	70.4	24.0	9.39	3.27	3.01	3.38	14.7	31.4	95.6	87.2
28	90.1	56.2	70.5	23.1	9.50	3.20	2.93	3.16	13.6	32.4	90.1	81.9
29	96.0	54.0	68.8	22.9	9.36	3.09	2.9	3.21	14.3	32.6	85.0	77.5
30	155		68.3	22.9	9.19	2.99	2.85	3.18	14.4	41.8	81.5	73.7
31	132		66.9		9.34		2.87	3.31		42.8		69.9
Total	3239	2276	1521	947.4	417.8	201.1	95.13	96.25	223.9	759.5	2663	3546
Mean	104.5	78.5	49.1	31.6	13.5	6.70	3.07	3.10	7.46	24.5	88.8	114.4
Max	183	122	70.5	63.7	22.7	9.73	3.45	3.66	14.9	42.8	108	223
Min	53.5	54	28.3	22.9	9.02	2.99	2.85	2.77	3.17	14.9	45.4	69.3

[1] Water Survey of Canada data recorded at the Island Highway bridge in Duncan, BC.
Note: Discharge data is preliminary and subject to changes.

Table 15. Daily summary of carcasses examined, tags applied and tagged recoveries, by sex, for chinook in the upper Cowichan River, 2004.

Date	Carcasses Examined				Tags Applied				Tagged Carcasses Recovered			
	Unkn	Male	Female	Jack	Unkn	Male	Female	Jack	Unkn	Male	Female	Jack
02-Nov-04	0	10	3	1	0	8	2	1	0	2	1	0
03-Nov-04	0	14	17	2	0	10	12	2	0	4	5	0
04-Nov-04	0	13	5	4	0	11	4	4	0	2	1	0
05-Nov-04	0	2	1	3	0	2	1	3	0	0	0	0
07-Nov-04	0	0	16	0	0	0	10	0	0	0	6	0
08-Nov-04	0	2	17	3	0	1	12	3	0	1	5	0
09-Nov-04	0	10	14	8	0	8	12	6	0	2	2	2
10-Nov-04	0	30	8	11	0	21	6	8	0	9	2	3
12-Nov-04	0	22	20	14	0	21	15	14	0	1	5	0
15-Nov-04	0	15	41	2	0	11	28	2	0	4	13	0
16-Nov-04	0	25	30	14	0	19	21	12	0	6	9	2
17-Nov-04	0	24	37	11	0	19	26	11	0	5	11	0
18-Nov-04	1	12	10	10	0	10	9	10	1	2	1	0
19-Nov-04	0	11	6	11	0	9	4	9	0	2	2	2
22-Nov-04	0	9	8	5	0	9	7	5	0	0	1	0
23-Nov-04	0	5	10	6	0	5	6	6	0	0	4	0
24-Nov-04	1	9	15	3	0	8	13	3	1	1	2	0
25-Nov-04	1	2	7	8	0	2	6	7	1	0	1	1
26-Nov-04	0	9	8	4	0	7	7	3	0	2	1	1
29-Nov-04	0	0	8	1	0	0	5	1	0	0	3	0
30-Nov-04	0	7	9	7	0	5	8	6	0	2	1	1
01-Dec-04	0	0	8	4	0	0	7	3	0	0	1	1
02-Dec-04	0	4	3	2	0	3	3	2	0	1	0	0
03-Dec-04	0	2	0	1	0	2	0	1	0	0	0	0
06-Dec-04	0	0	1	4	0	0	1	4	0	0	0	0
07-Dec-04	2	1	5	3	0	1	4	3	2	0	1	0
08-Dec-04	0	1	3	2	0	1	3	2	0	0	0	0
09-Dec-04	0	2	1	1	0	2	1	1	0	0	0	0
Total	5	241	311	145	0	195	233	132	5	46	78	13

Table 16. Tags applied, carcasses examined and marks recovered, by sex, for chinook in the Cowichan River, 2004.

Sex	Tags Applied	Carcasses Examined	Marks Recovered	Percent Recovered
Male	195	241	46	23.59%
Female	233	311	78	33.48%
Total Adult	428	552	124	28.97%
Jack	132	145	13	9.85%
Total Population	560	702	142	25.36%

Table 17. Petersen mark-recapture estimates, stratified by sex, for Cowichan River chinook, 2004.

Sex	Population Estimate	95% Confidence Limits	
		Lower	Upper
Male [1]	1009	752	1266
Female	924	749	1100
Total Adult	**1898**	**1606**	**2190**
Jack	1387	719	2055
Total Population	2758	2355	3160

[1] Adult males only, jacks not included.

Table 18. Incidence of tagged adult chinook carcasses recovered on the spawning grounds by recovery period and sex, Cowichan River, 2004.

Recovery Period	Days of Recovery	Tagged Recoveries			Total Recoveries			Tag Incidence (%)		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
02-Nov to 05-Nov	4	8	7	15	39	26	65	20.51	26.92	23.08
07-Nov to 12-Nov	5	13	20	33	64	75	139	20.31	26.67	23.74
15-Nov to 19-Nov	5	19	36	55	87	124	211	21.84	29.03	26.07
22-Nov to 26-Nov	5	3	9	12	34	48	82	8.82	18.75	14.63
29-Nov to 03-Dec	5	3	5	8	13	28	41	23.08	17.86	19.51
06-Dec to 09-Dec	4	0	1	1	4	10	14	0.00	10.00	7.14
Total	28	46	78	124	241	311	552	19.09	25.08	22.46
Chi-Square test result:								3.94	4.19	
Critical Chi-Square (df = 5; alpha = 0.01)								15.09	15.09	

Table 19. Proportion of the tag application sample recovered on the spawning grounds by application period and sex, Cowichan River, 2004.

Application Period	Days of Application	Tags Applied			Tagged Recoveries			Percent Recovered		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
02-Nov to 05-Nov	4	31	19	50	8	7	15	25.81	36.84	30.00
07-Nov to 12-Nov	5	51	55	106	13	20	33	25.49	36.36	31.13
15-Nov to 19-Nov	5	68	88	156	19	36	55	27.94	40.91	35.26
22-Nov to 26-Nov	5	31	39	70	3	9	12	9.68	23.08	17.14
29-Nov to 03-Dec	5	10	23	33	3	5	8	30.00	21.74	24.24
06-Dec to 09-Dec	4	4	9	13	0	1	1	0.00	11.11	7.69
Total	28	195	233	382	46	78	115	23.59	33.48	30.10
Chi-Square test result:								5.69	7.82	
Critical Chi-Square (df = 5; alpha = 0.01)								15.09	15.09	

Table 20. Sex composition of chinook in the tag application and recovery samples from the Cowichan River spawning grounds, 2004.

	Application sample by recovery status				Recovery sample by mark status			
Sex	Sample Size	Recovered	Not Recovered	Total	Sample Size	Marked	Not Marked	Total
Male	195	37.1%	49.0%	45.6%	241	37.1%	45.6%	43.7%
Female	233	62.9%	51.0%	54.4%	311	62.9%	54.4%	56.3%
Chi-Square test result:				5.04				2.80
Critical Chi-Square (df = 1; alpha = 0.01)				6.64				6.64

Table 21. Sex composition of chinook in the tag application and recovery samples from the Cowichan River spawning grounds, 2004. (jacks included).

	Application sample by recovery status				Recovery sample by mark status			
Sex	Sample Size	Recovered	Not Recovered	Total	Sample Size	Marked	Not Marked	Total
Male	195	33.6%	35.2%	34.8%	241	33.6%	34.8%	34.6%
Female	233	56.9%	36.6%	41.6%	311	56.9%	41.6%	44.6%
Jack	132	9.5%	28.1%	23.6%	145	9.5%	23.6%	20.8%
Chi-square test result:				25.58				16.34
Critical Chi-square (df = 2; alpha = 0.01)				9.21				9.21

Table 22. Total adult chinook returns to the Cowichan River for the years 1975-2004.

Year	Natural Spawners	Broodstock Removal	Native Catch	Total Return
1975	6,500		900	7,400
1976	3,460		1,000	4,460
1977	4,150		1,000	5,150
1978	4,370		500	4,870
1979	8,750	195	500	9,445
1980	5,950	337	1,500	7,787
1981	5,500	282	1,500	7,282
1982	4,500	534	1,000	6,034
1983	4,500	242	250	4,992
1984	5,000	278	355	5,633
1985	3,500	175	1,000	4,675
1986	1,832	315	800	2,947
1987	1,937	582	800	3,319
1988	6,200	678	681	7,559
1989	5000 [1]	535 [2]	1,055	6,590
1990	5,300	326	820	6,446
1991	6000 [3]	1,755	250	8,005
1992	8,500	1,850	260	10,610
1993	5,058	1,970	295	7,323
1994	5,050	1,357	345	6,752
1995	14,300	2,149	533	16,982
1996	12,980	1,615	810	15,405
1997	9,845	125	191	10,161
1998	4,371	1,485	1,073	6,929
1999	4,500	1,659	233	6692 [4]
2000	5109 [5]	1,529	89	7027 [4]
2001	3282 [5]	1,732	918	6232 [4]
2002	2505 [5]	1,480	1,500	5785 [4]
2003	2494 [6]	862 [7]	825	4481 [4]
2004	2146 [6]	575	320	3341 [4]

[1] For the years 1989 to the present, the number of natural spawners was calculated as the number of adults recorded at the fence minus the adults removed for broodstock above the fence. In years when fence counts were incomplete, the cumulative run timing curve was used to expand the count.

[2] This number is the total broodstock removed and may include some jacks.

[3] Due to early flooding, estimate is based on expansion of swim surveys and weir counts.

[4] Includes an estimated 300 chinook lost to seal predation in the Cowichan estuary.

[5] For the years 2000 to the present, the adult fence count totals used in calculating natural spawners was adjusted using jack/adult ratios obtained from the spawning grounds.

[6] This estimate was derived by using an extrapolated fence count as well as adjustment using the jack/adult ratios abtained from the spawning grounds.

[7] The 108 adult chinook which were collected and later released downstream of the fence site were not included.

Table 23. Total jack chinook returns to the Cowichan River for the years 1982-2004.

Year	Natural Spawners [1]	Broodstock Removal	Native Catch	Total Return
1982	2000 [2]	0	1,000	3,000
1983 [3]	5,460	0	1,000	6,460
1984	4,042	0	700	4,742
1985	2,200	0	1,000	3,200
1986	5,890	0	800	6,690
1987	2,085	0	800	2,885
1988 [4]	4,216	70 [5]	450	4,736
1989	995	94 [5]	250	1,339
1990	15,198	1	150	15,349
1991	1,341	444 [5]	70	1,855
1992	4,589	108 [5]	12	4,709
1993	5,765	196 [5]	22	5,983
1994	13,345	145	227	13,717
1995	10,517	564 [5]	120	11,201
1996	6,483	275 [5]	150	6,908
1997	6,771	79	0	6,850
1998	3,065	201	0	3,266
1999	1,380	1	89	1,470
2000 [6]	1,879	14	0	1,893
2001	1,862	0	120	1,983
2002	1,685	0	0	1,685
2003	1,822	14	0	1,836
2004	1,503	20	4	1,527

[1] The number of natural spawners was calculated as the number of adults recorded at the fence minus the adults removed for broodstock above or at the fence. In years when fence counts were incomplete, the cumulative run timing curve was used to expand the count.

[2] Estimate based on broodstock sampling

[3] For 1983 - 1987 estimate were based on visual counts

[4] For 1988 - 2004 estimate based on fence counts.

[5] Broodstock information obtained from field records and may differ slightly from official records.

[6] For the years 2000 - 2004, the adult fence count totals used in calculating natural spawners was adjusted using jack/adult ratios obtained from the spawning grounds.

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Figure 1. Cowichan River survey areas.

Swim survey locations were:

1 - Bird House Pool
2 - Road Pool
3 - Train Trestle (mile 70.2)
4 - Old Pick-up Site
5 - Maple Tree
6 - Three Firs Pool
7 - Skutz Falls
8 - Marie Canyon
9 - Bible Camp
10 - Cowichan Side channel
11 – Sandy Pool
12 – Sewer
13 – J.C. Pool

Swim survey areas:

Bird House (1) to Three Firs Pool (6) represents the upper survey section.

Marie Canyon (8) to enumeration fence (A) represents the middle survey section.

A - Refers to the adult enumeration fence

Tag recovery locations:

Locations numbered 1 to 45 are in the upper river section, those numbered 46 to 83 are in the middle river section.

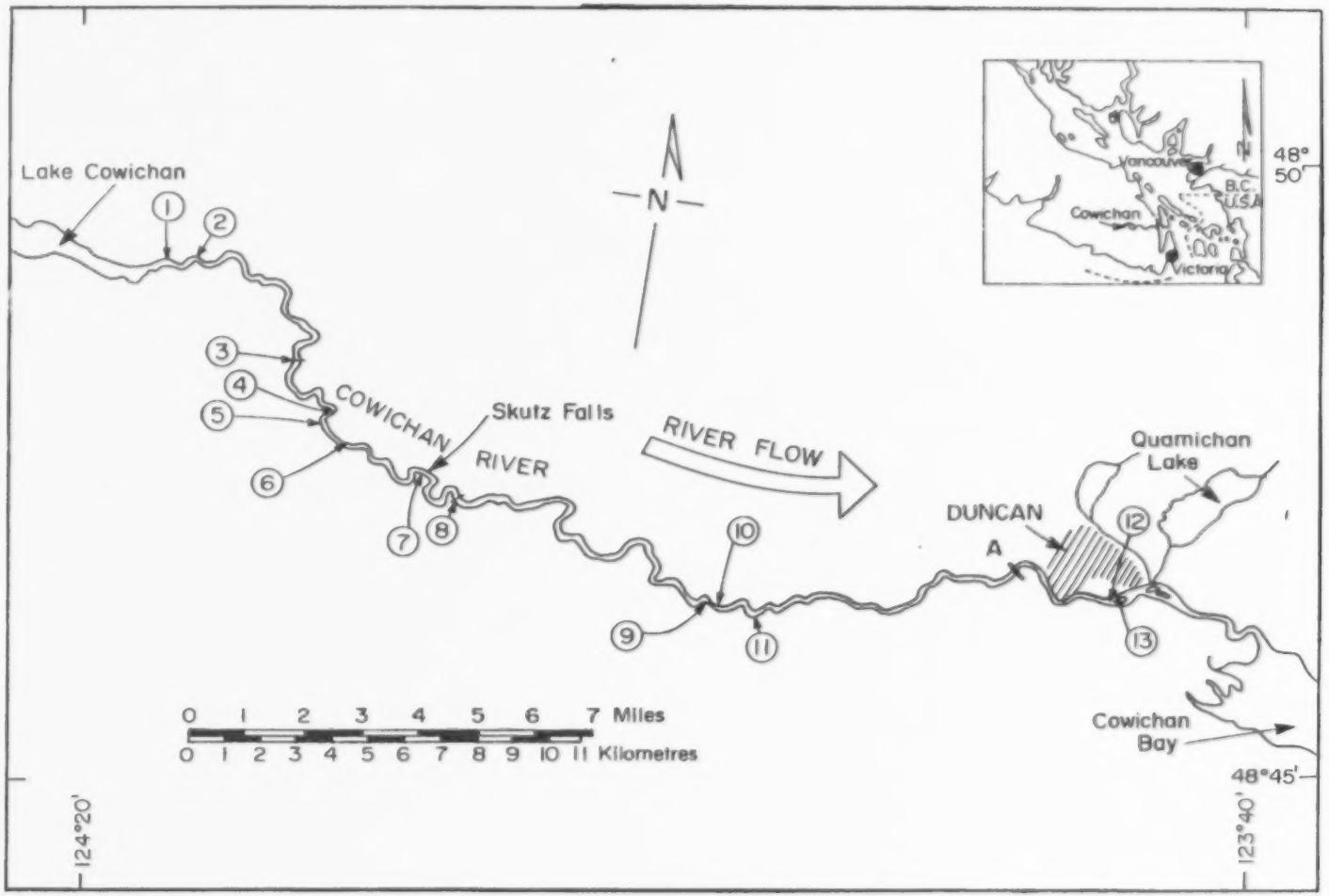

Figure 1. Cowichan River survey areas

Figure 2. River management zones for the First Nations food fishery.

A-Cliffs to Silver Bridge

B-Silver Bridge to J.C.'s Place

C-Quamichan to Black Creek

D-Powerline to Elliot's Barn

E-Elliot's Barn to Brian's Pool

F-Brian's Pool to Clem Clem and part of Koksilah

G-Clem Clem to Mouth of River

H-North Side to Fourplex

I-Fourplex to Meriner's Slough

J-Meriner's Slough to Mouth of River

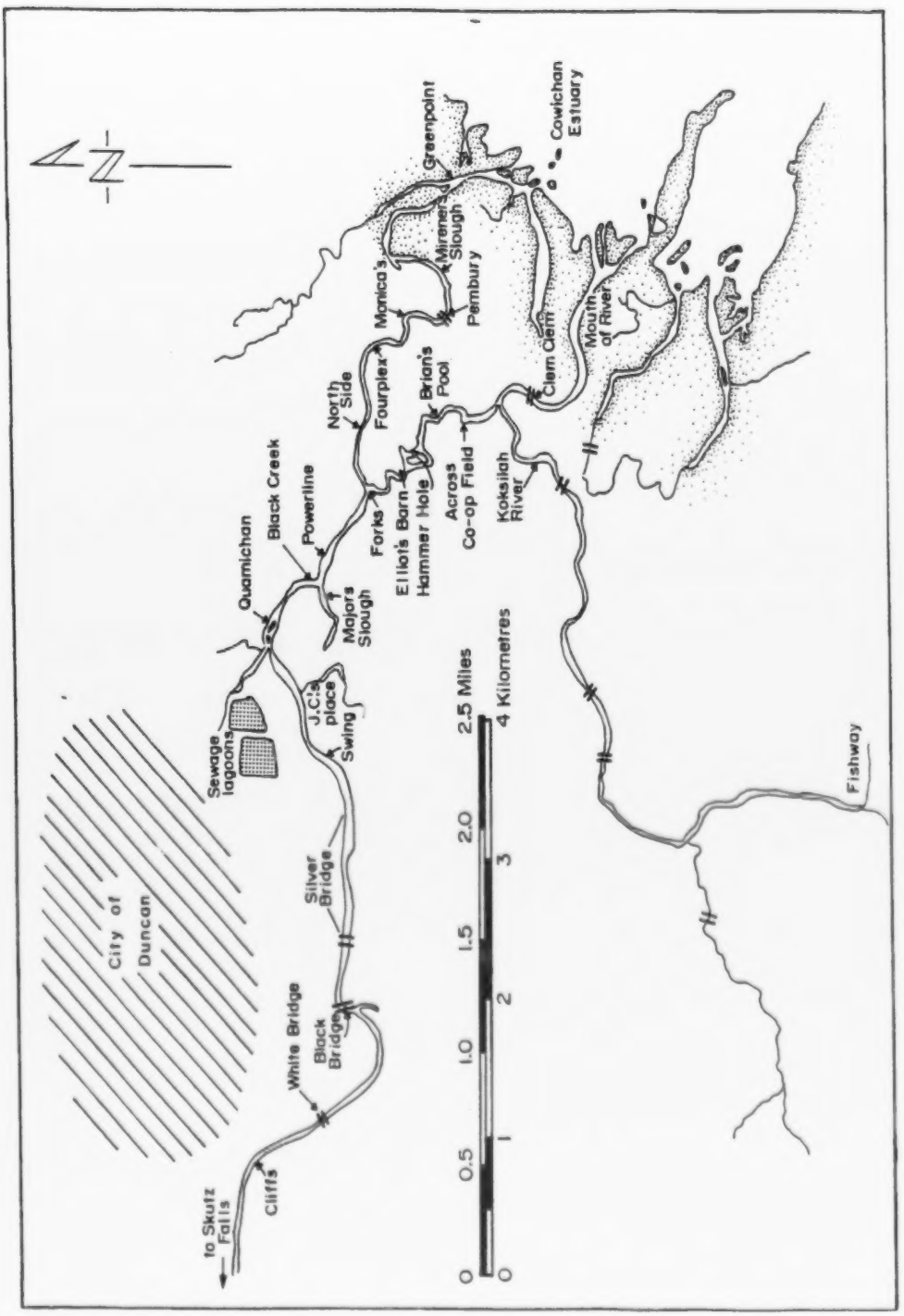

Figure 2. River management zones for the First Nations food fishery.

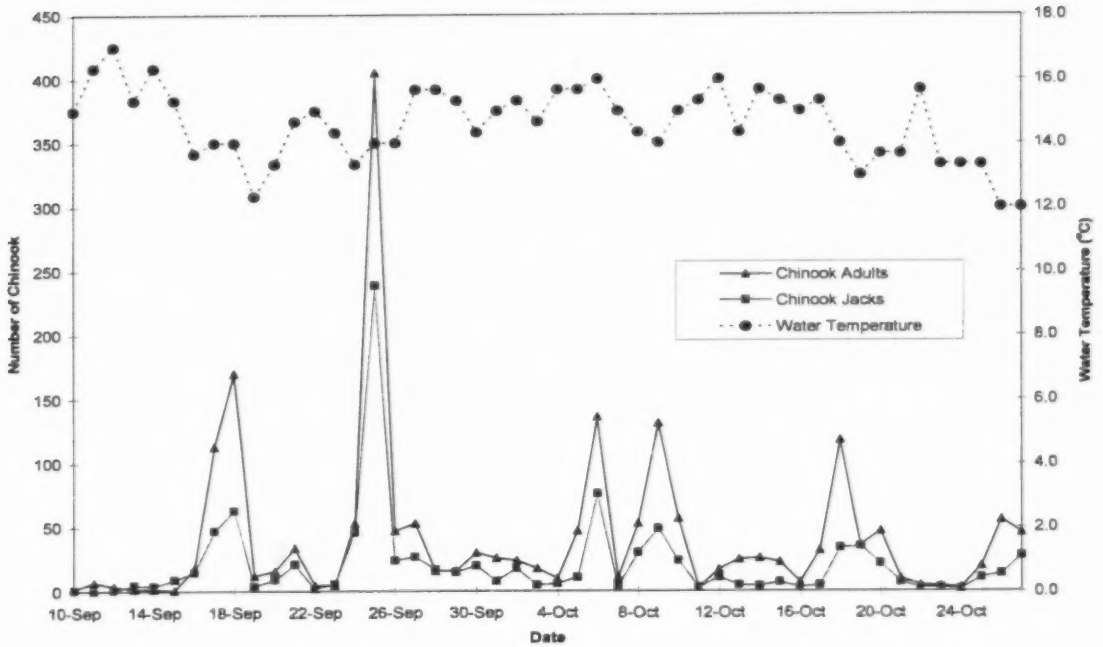

Figure 3a. Daily fence counts of adult and jack chinook and water temperature at the fence site, Cowichan River, 2004.

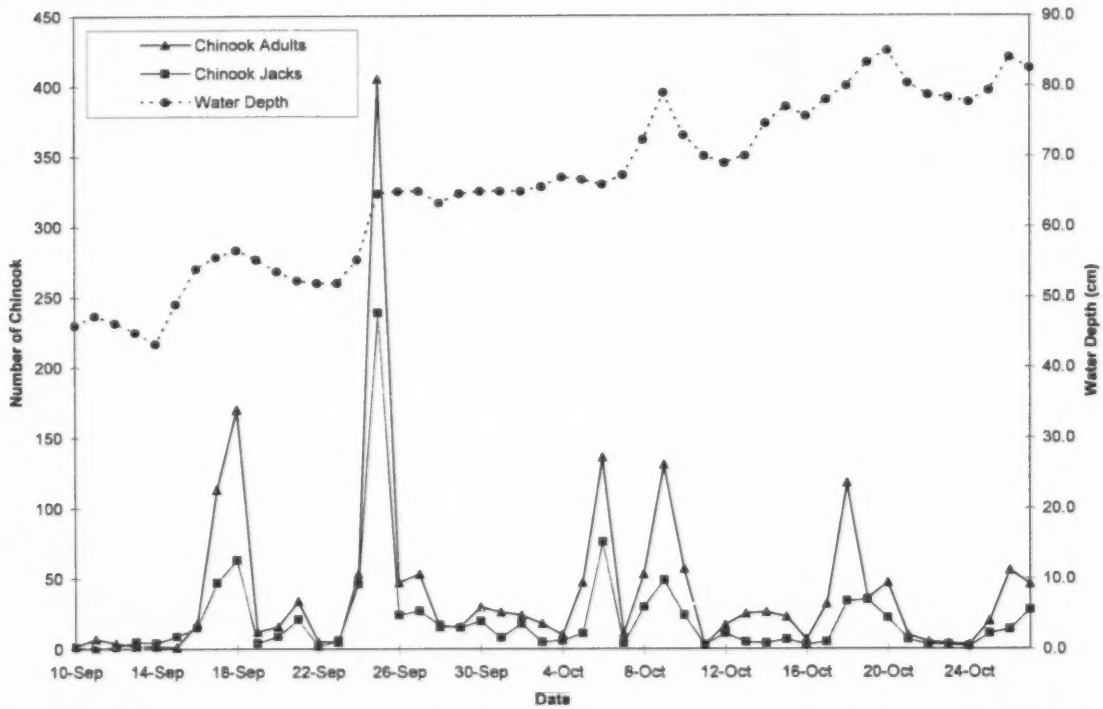

Figure 3b. Daily fence counts of adult and jack chinook and water depth at the fence site, Cowichan River, 2004.

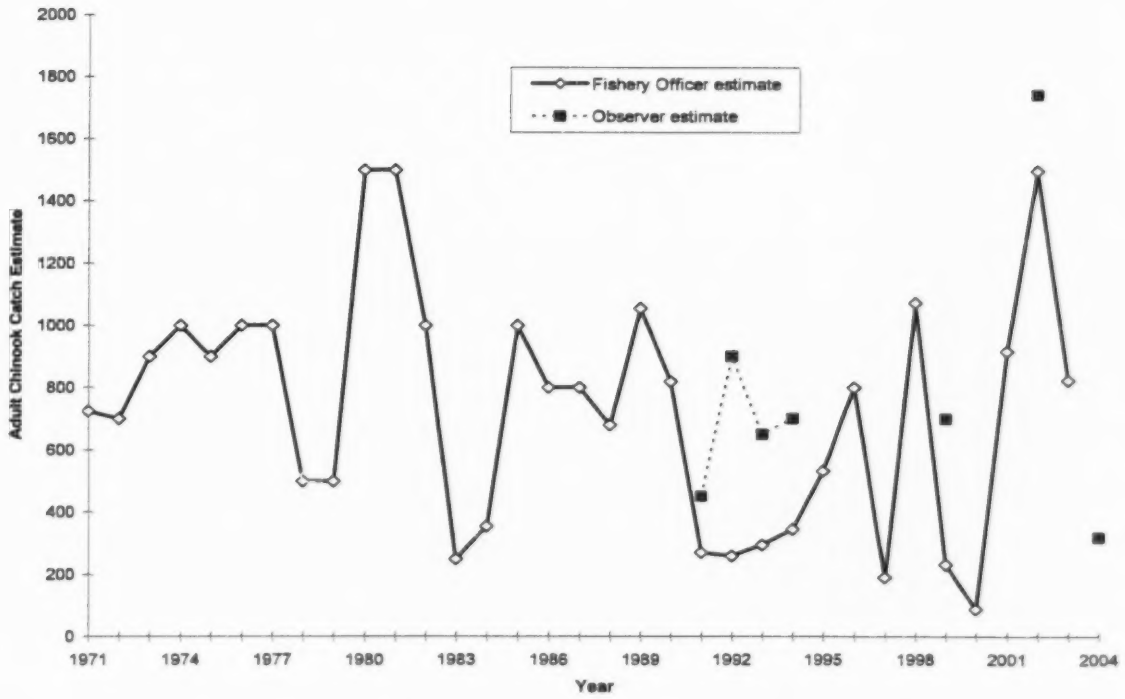

Figure 4. Adult chinook catch from the First Nations food fishery, Cowichan River, 1971-2004.

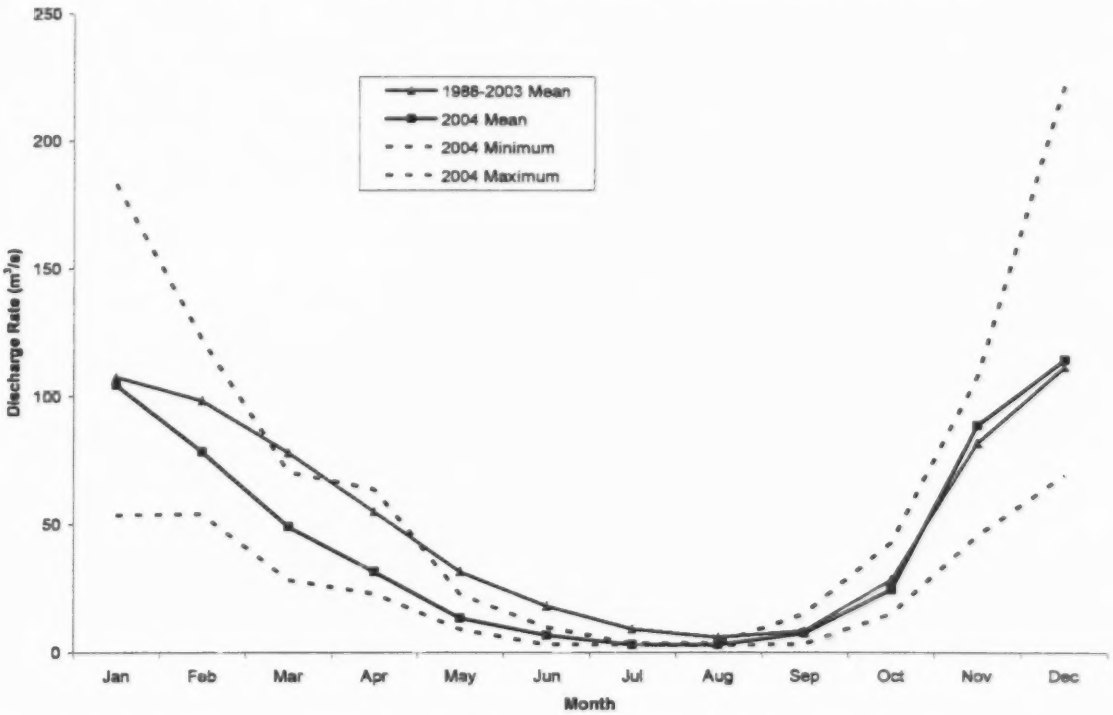

Figure 5. Monthly Cowichan River discharge (m^3/s) in 2004 compared with historical values.
Note: Discharge data is preliminary and subject to changes.

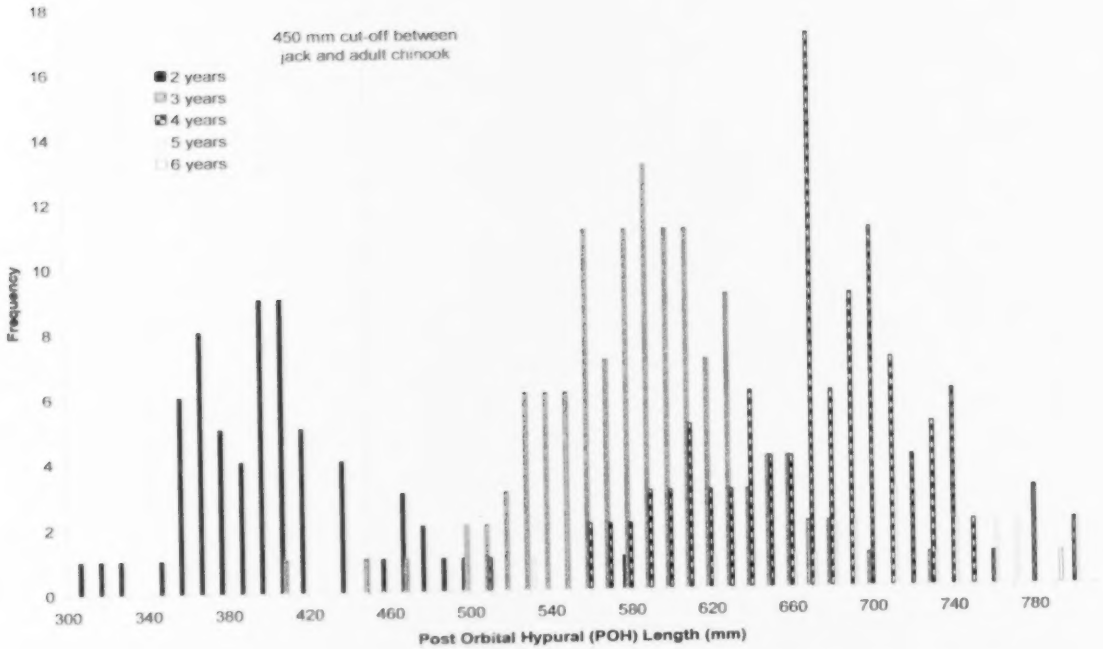

Figure 6. Adult and jack chinook length-frequencies collected from the Cowichan River spawning grounds, 2004.

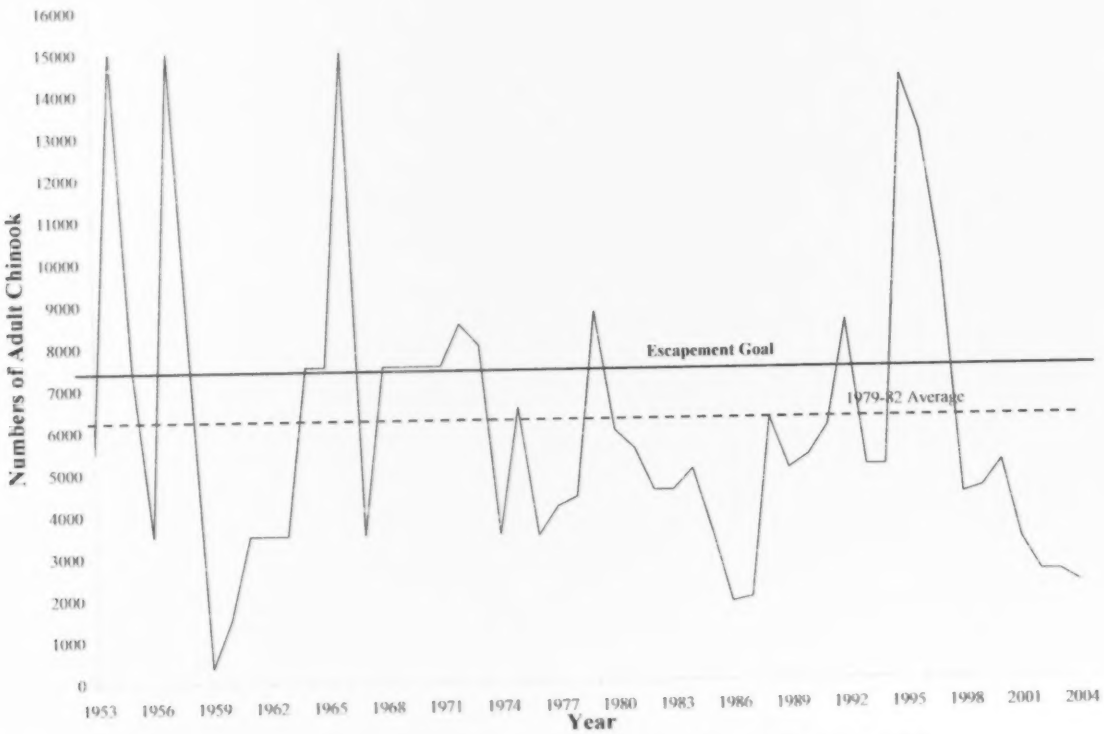

Figure 7. Annual adult chinook escapement estimates for the Cowichan River, 1953-2004.

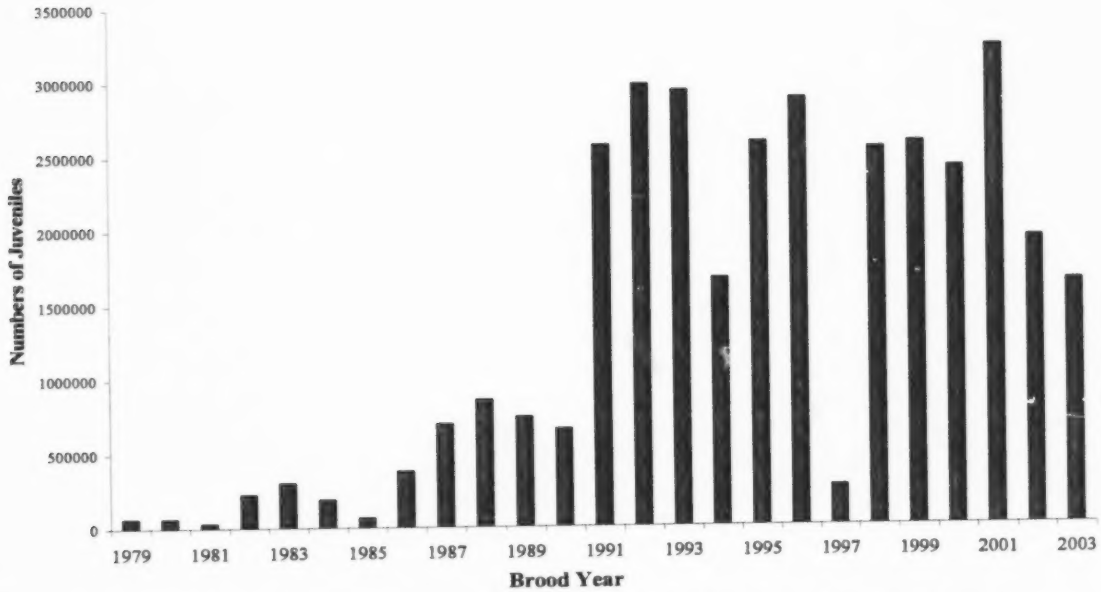

Figure 8. Annual releases of hatchery chinook into the Cowichan River as fry (3 g) and as pre-smolts (6 g), brood year, 1979-2003.

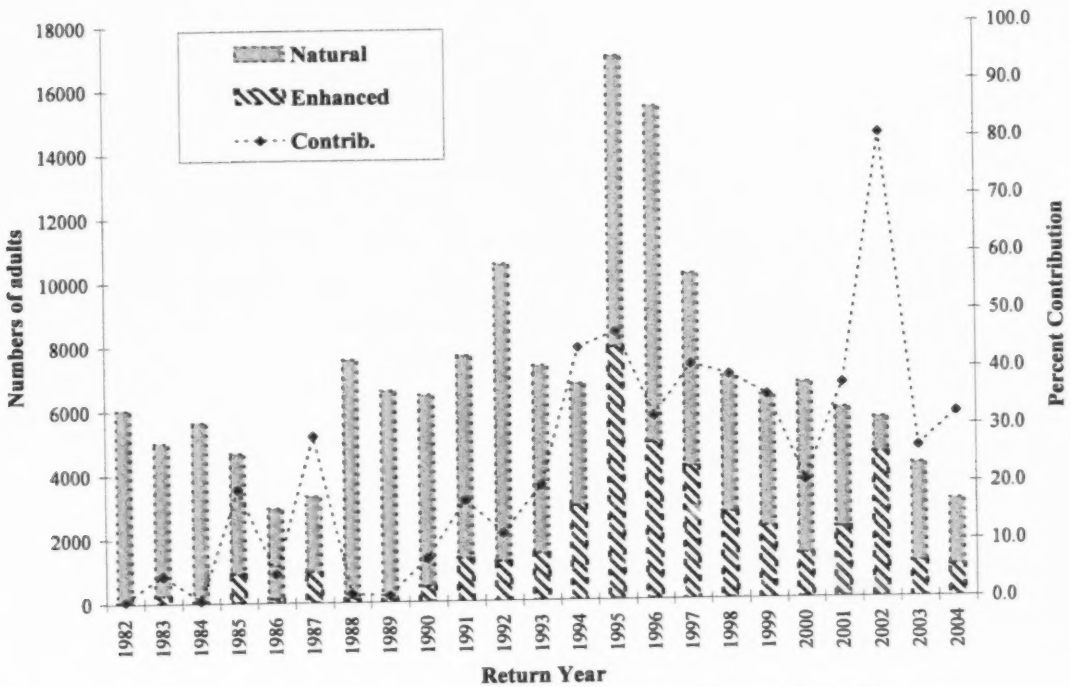

Figure 9. Annual natural and enhanced contributions to adult chinook escapement, Cowichan River, 1982-2004.